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RUSSIAN ENGINEERS STUDYING THE DIRECTION LINE OF THE EAST CHINESE RAILWAY.

THE RUSSIANS IN MANCHURIA.

The Russian Asiatic possessions, bordering upon China for an extent of more than 3,600 miles, would find themselves in a very bad position on the day on which the "yellow peril" threatened Europe, since, before reaching the latter, the innumerable Chinese hordes would, in the first place, invade Siberia by making their irruption thereinto through Manchuria. That is why the Russian government, while endeavoring to maintain immutable relations of friendship with the Celestial Empire, is seeking to provide against this real danger by every means in its power. And that is why the Russians have long coveted Manchuria and Mongolia, the possession of which would protect Siberia against any abrupt invasion, since the conquest of these two Chinese provinces would permit of pushing the Russo-Chinese frontiers far into the interior of China.

The construction of the Trans-Siberian Railway was actively pursued, especially because of the latter's strategetic importance, from the viewpoint of the defense of the Russian interests in the Far East; and it is due to this railway that it is possible for Russia to assume the present preponderant situation therein and seize upon Manchuria, without fear of any intervention whatever, in taking advantage of the troubles in China.

Not content with the strategic line of Oussouri, between Khabarovsk and Vladivostok, which is already entering Manchuria obliquely, and desirous of penetrating to the very heart of this province, the Russians skillfully succeeded in obtaining from the Chinese government the concession of a line of penetration called the East Chinese—the ideal prolongation of their Trans-Siberian through Manchuria, with a trunk bifurcating at Kharbin in order to descend to the east and end at Port Arthur.

The construction of this railway was abruptly interrupted by the Chinese insurrection, and its completion has been retarded up to the present by the attacks of plunderers, against whom the Cossacks are as yet contending.

At the time of the opening of hostilities the Russian engineers and laborers, attacked by the Chinese, were overcome and had to abandon work on this railway and betake themselves hastily in bands to Siberia. Later on the Chinese soldiers occupied the stations in course of construction, of which, however, they did not long remain masters, since the Russian forces, in rapidly invading Manchuria, put them to flight.

At the first alarm the Cossacks crossed the Amoor River, which forms the natural frontier between Russia and China, and, by forced marches, penetrated to the interior of Manchuria. They in the first place razed Aigoon, a fortified Chinese town situated upon the right bank of the Amoor at about twenty-four miles from Blagovestchensk, a Russian town which was for a moment seriously harassed by the Chinese. After subsequently taking the town of Mergen, the Russian troops, ever victorious, seized successively upon all the Manchu towns, such as Khaïlar, Tsitsikar, Ningoota, Mookden, etc., so that Manchuria is at present entirely in the hands of the Russians and may be considered as already practically annexed to Russia, despite the earnest protestations of that power.

Manchuria, divided into the provinces of Amoor, Hirin and Mookden, is known in China by the name of Doon-Sane-Cheng, which means "three provinces of the East." It is a mountainous country of sorry aspect, and is three times larger than Japan. The climate is exceedingly salubrious. The cold in winter reaches from 45 to 50 degrees C. below zero. Spring is short, summer is very hot, and autumn follows apace. The population of Manchuria is estimated, approximately, at fifteen million inhabitants, composed of Chinese, Manchus, Coreans, Daoors, Orotchones, Birares, Manegres, Goldes, Solons, Booriates, Tchiptchines and Olotes. The Chinese are naturally in great majority; after them come the Manchus to the number of about 700,000, and the Coreans to the number of about 50,000.

The dominant religion of the country is Buddhism, one of the varieties of which, Chamanism, is likewise professed by the tribes of the Mongolian race.

Agriculture is the principal occupation of the sedentary population, which cultivates wheat, oats, barley, millet, buckwheat, rice, etc. With a variety of millet the Chinese prepare their klanchine (brandy), and from a species of bean they extract oil. As the men, women and children of Manchuria are great smokers, the cultivation of tobacco and the poppy (the juice of which furnishes opium) is carried on upon a large scale. Kitchen gardens surround all the fanza (houses). Since they eat neither meat nor milk-food, the Chinese are vegetarians par excellence. They are very fond of garlics, onions and pepper.

In the mountains of Manchuria is found much ginseng, a root which the Celestials consider as a panacea and corroborative without a rival. The raising of cattle occupies the nomad population of the country, which, since it consumes no meat itself, passes it over to the Siberians of the province of the Amoor.

The administrative organization of Manchuria leaves much to be desired. A sort of permanent anarchy still reigns there, and robbery and brigandage flourish in broad daylight and too often go unpunished.

It is therefore in no wise surprising that the aboriginal population receives the Russians with open arms and expresses sympathy with these welcome conquerors, who certainly will not fail to set this badly governed country in some little order by introducing thereinto their authoritative administration.—Le Monde Illustré.

RUSSIAN LABORERS ABANDONING THE RAILWAY AT THE OPENING OF HOSTILITIES—CROSSING THE RIVER ARGOONE.

THE GOLD USED BY THE ANCIENT EGYPTIANS.

By J. H. Gladstone, D.Sc., F.R.S.

M. Berthelot has recently made a communication to the French Academy on the subject of Egyptian gold (Comptes Rendus, 1900, vol. cxxxi., [9], p. 461). He gives an analysis of specimens of gold leaf from mummies of the VI. and XII. Dynasties and another specimen belonging to the Persian era. I have recently had the advantage of examining gold-foil from the royal tombs of the First Dynasty, discovered in the early part of this year (1900) by Prof. Flinders Petrie; the analyses have not yet been published. I had previously examined a specimen of gold of Adu I. of the VI. Dynasty, and another from a casket of Amenhotep II. of the XVIII. Dynasty (Dendireh, Petrie, p. 61; and Proc. of Soc. of Antiquaries of Scotland, vol. xxx., p. 33).

I have placed the results of all these observations in the following table, adopting Berthelot's arrangement, in which all the other substances besides the gold and silver have been classified under the heading of "Organic Matter," etc.:

King.	Dynasty.	Gold.	Silver.	Organic matter, etc.	Observer.
Zet	I.	79.7	13.4	6.9	Gladstone.
Merseckha.	I.	84.2	14.3	1.5	"
Qa	I.	84.0	13.0	3.0	"
Adu I	VI.	77.9	18.0	4.1	
		81.7	16.1	2.2	"
—	VI.	92.3	3.2	4.5	Berthelot.
		92.2	3.9	3.9	
—	XII.	90.5 / 90.0	4.5	5.0	"
Amenhotep II	XVIII.	81.1	11.4	7.5	Gladstone.
		83.5	11.7	4.8	"
Persian Era	—	99.8	—	—	Berthelot.

The specimens analyzed by me contained little, if any, copper. M. Berthelot found no other metal present in his specimens. It is evident, on comparing these figures, that there is no similarity of composition between these different specimens of gold, except that the three kings of the First Dynasty probably drew their supplies from the same source. It is evident from the case of Amenhotep II. that, down to the sixteenth century B. C., the Egyptians continued to use the native alloy; some specimens of which almost approached that which would be designated electrum.

Some of the foil is much tarnished, and this I found to be due to the formation of chloride of silver, which, of course, turns dark in color when exposed to the light. As this appears as a superficial crust, we seem here to have an instance of the slow diffusion of one part of the alloy—the silver—till it reaches the outside surface, where it meets with the chlorides that exist in the sands of the desert.

It is well known that Seti I., of the XIX. Dynasty, and his son Rameses II., worked very extensive gold mines in the Nubian desert. It is stated by Arthur Phillips that "the gold of Nubia is of a deep yellow color and remarkably pure." This difference could not fail to be noticed by the Egyptians; and in the great Harris papyrus, containing the annals of Rameses III., about B. C. 1200, it is perfectly evident that they distinguished different qualities of gold. Mention is made of gold, pure gold, good gold, and white gold; of best gold, and gold of the second quality; of fine gold of the land, and gold of the land of Koebti, and of Kush (see "Records of the Past," vol. vi.).—The Chemical News.

ALLOTROPIC FORMS OF SILVER.

From calorimetric determinations of the rise of temperature resulting from the solution of pure silver, in different forms, in mercury, Berthelot considers that the former metal exists in at least four allotropic conditions. The silver employed was (1) beaten silver leaf; (2) the metal obtained from this leaf, maintained at 500 to 550 deg. C. for twenty hours in a current of oxygen; (3) silver crystalized in fine needles, obtained by the slow electrolytic decomposition of a ten per cent silver nitrate solution; (4) precipitated silver, obtained on a copper foil suspended in a dilute solution of the nitrate dried (*a*) at ordinary temperatures, (*b*) at 120 deg. C.; (5) the same, dried at a temperature approaching dull redness. Of these, the third and fifth give figures which are practically identical and point to the fact that crystalline silver and its amorphous form dried at 120 deg. C. are transformable without appreciably modifying the thermal constant. The other three states, however, show marked differences in molecular arrangement. (1) Silver leaf gives the figure 2.03 deg. Cal. (2) Silver obtained by the transformation of the foil in oxygen at about 550 deg. C. gives 0.47 deg. Cal. (3) Crystalline silver from electrolytic deposits 0.10 deg. Cal. (4) The precipitate on copper dried at ordinary temperatures 1.19 Cal.; dried at 120 deg. C., 0.76 deg. Cal. (5) The same dried at 120 deg. C., 0.08 deg. Cal. The variation between the two forms of silver precipitated by copper, but dried at different temperatures, seems to point to the fact that transformation of the metal commences at 120 deg. C., which doubtless would be complete at 550 deg. C. These results have an important bearing, not only on the thermo-chemical constants hitherto attributed to silver, which are only true of the metal in a certain form, but also on the thermo-chemical factors of other metals; for instance, iron, which exists in numerous allotropic conditions.—Comptes Rend.

OLIVE-TREE MANNA.

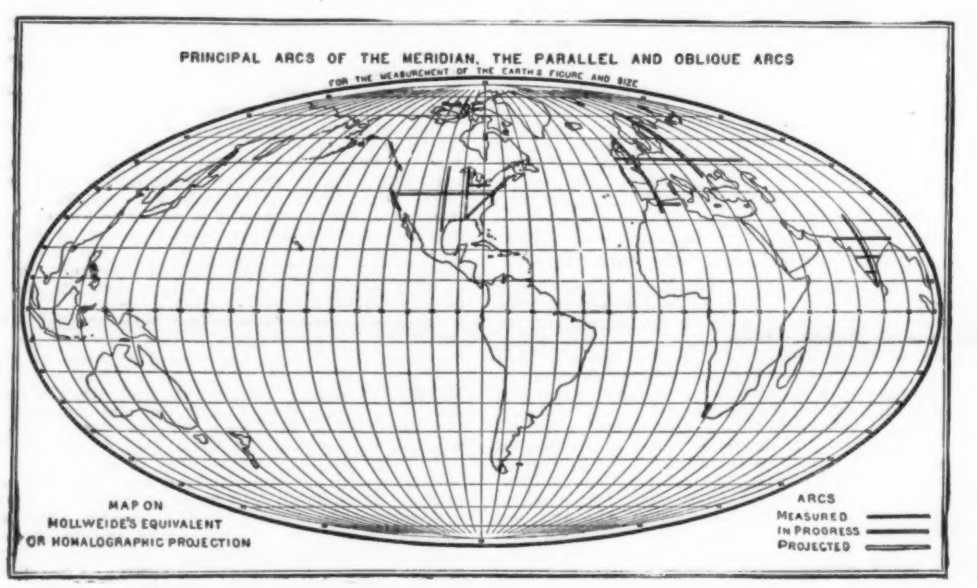
J. A. Battandier has examined the manna collected by Trabut in the gardens of Mansourah, where it is secreted in quantity by old olive trees. It has the odor, appearance, and taste of ordinary ash manna. It contained 52 per cent of mannite, identical with that from Fraxinus manna, 7.3 per cent of reducing sugar, and 9.8 per cent of gum.—Journ. Pharm. Chim. [6], 13, 177.

THE FIGURE OF THE EARTH.*

THE United States Coast and Geodetic Survey has just published a quarto volume containing an account of the transcontinental triangulations and measurements of an arc of the parallel in latitude 39 degrees. It also has ready for publication the manuscript giving the result of an oblique arc in the eastern part of the United States. Both are contributions of great length and are among the first of their kind in America.

Before entering upon the detail of the two arcs it may not be out of place to state that in order to obtain a measure of the dimensions of the earth, as represented by a spheroid; that is, by a surface generated by the rotation of an ellipse about its minor axis, it is essential that we should be in possession of at least two arcs or of an equivalent thereof. For combinations of two arcs of the meridian, their mean latitudes should differ widely; the same is true for the combination of two arcs of the parallel. We may also obtain an arc of the meridian with one of the parallels, but in every case the measures should be of considerable extent. Arcs of less than 5 degrees (about 556 kilometers or 345 statute miles) would now be regarded as short ones. It has been stated that one of the arcs is an oblique arc, and as it possesses a great range of latitude and also of longitude and is supplied with a large number of astronomical measures, it is of itself sufficient for the deduction of values for the dimensions of the earth. Furthermore, it may be remarked that for any relatively small part of the earth's surface an osculating spheroid may be determined, as, for instance, was done for our oblique arc. Such a spheroid has the property that its surface is in best accord, as regards curvature, with the actual or physical one, the latter considered as a mathematical surface of equilibrium and generally known as geoid.

The definition of an osculating spheroid thus implies that the sum of the squares of the difference between the various astronomic and geodetic measures be a minimum. The mathematical treatment of the combination of the arc measures differs according to their nature, whether they are extended in a certain direction or whether large areas are covered, but in its generality it is necessarily laborious.



The salient points of the two arcs measured by the U. S. Coast and Geodetic Survey and the results reached may now be briefly stated. First, the arc of the parallel in latitude 39 degrees.† It extends from Cape May, N. J., on the Atlantic coast, to Point Arena, Cal., on the Pacific coast, and ranges over 48 degrees 46 minutes of longitude, with a linear development of about 4,225 kilometers, or 2,625 statute miles. The triangulation is supported by ten base lines with an aggregate length of 53¼ statute miles, the longest or Yolo base being 10.9 miles in length, one-half of these lines having a smaller probable error of measure than one part in a million. A characteristic of the triangulation is its rigidity imparted to it by quadrilaterals and other polygons. In crossing the Rocky Mountains, many of its sides exceed one hundred miles in length, and there is one side reaching to a length of 294 kilometers, or 183 statute miles; the altitude of many of the stations is also considerable, reaching to 4,300 meters, or 14,108 feet, in the case of Pike's Peak, and to 14,421 feet at Mount Elbert. All geometrical conditions subsisting in the triangulation are satisfied by adjustment, inclusive of the required accord of the base line, so that the same length for any given line is found no matter from what line one may start. This involved much heavy work; for instance, the triangulation adjustment between the Salina and El Paso base demanded the simultaneous solution of ninety-nine normal equations (with as many unknowns). In addition, the figures required the evolution of a correction to each of the two hundred and twenty-five observed directions.

Coming to the astronomical measures, we have distributed over or near the arc one hundred and nine latitude stations, occupied almost exclusively with zenith telescopes; there are, also, seventy-three azimuth stations, various methods having been used, and lastly we have twenty-nine telegraphically determined longitudes. These, of course, are of paramount importance for an arc of the parallel. There cannot be too many longitude stations in consequence of that great stumbling-block in geodesy, the local deflections of the vertical or plumb-line. These deflections of the zenith from a normal direction have been divided into two groups—those which are regional or manifest themselves with marked common features over thousands of square miles, and those which are quite local and greatly depend upon the surface features immediately surrounding them.

These deflections, even in level countries, average about 2.5 seconds; but in mountainous regions this deflection is greatly surpassed. Thus we find for deviation of the plumb-line at Patmos Head station 12 seconds to the north, at Colorado Springs 25 seconds to the west, at Salt Lake City about 17 seconds, and at Ogden about 15 seconds to the east, at Genoa Station, Nev., nearly 29 seconds to the west, the quantities depending to some extent on the spheroid of reference; but their amount and direction are obviously well accounted for by the position of known attracting masses. In connection with this, continental attraction may manifest itself and be recognized by the astronomical amplitude of the longitudes of extreme stations of a long arc being in excess of the corresponding geodetic amplitude. The matter cannot be further pursued here in detail, but it may suffice to state that the average curvature of the equipotential surface of the geoid along the parallel of 39 degrees approaches for about four-sevenths of the arc from its eastern end closely to that of the Clarke spheroid; whereas, for the remaining three-sevenths, or for the region across the Rocky Mountains to the Pacific, the curvature comes more nearly to that of the Besselian spheroid. In the published paper two tables are given containing the results needed for combination with any other arc, and, in conclusion, some preliminary rough combinations of American arcs are presented; all of which point to a reference spheroid of larger dimensions than those of the Besselian and are in favor of continuing the use of Clarke for reference.

The second arc under consideration extends from Calais, Me., in the northeast and opposite the Canadian boundary, to the Gulf of Mexico, and terminates at New Orleans, La. It is known as the Eastern Oblique Arc of the United States. Its length is 2,612 kilometers, or 1,623 statute miles; its difference of latitude is 15 degrees 1 minute, and of longitude 22 degrees 47 minutes. The general direction is therefore favorable, and the length ample to secure fair results for an osculating spheroid. In the main the triangulation follows the Appalachian chain of mountains; in Western North Carolina and Eastern Tennessee it bifurcates, leaving an oval space between the two branches. The length of sides depends upon six base lines, and in general the development is closely accommodated to the hypsometric and other natural conditions along the course. It includes among its stations the two highest points in the eastern part of the United States, viz., Mount Washington, N. H., rising to about 1,920 meters, or 6,300 feet, and Mount Mitchell, N. C., rising to about 2,038 meters, or 6,687 feet.

The adjustment of the whole triangulation is effected precisely as explained in the use of the arc of the parallel; the small reduction to the sea-level of the observed horizontal directions, on account of the altitudes sighted, was only applied when exceeding 0.05 second. The principal labor of adjustment was demanded by the necessity of bringing into accord the measured lengths of the Fire Island, the Massachusetts and the Epping base lines, and fulfilling the geometrical conditions of the intervening net of triangles. This demanded the satisfying of fifty-seven conditions, and involved the simultaneous solution of an equal number of normal equations and the working out of 131 corrections of observed directions. Of astronomical measures we have seventy-one latitude stations, seventeen longitude stations, and fifty-six azimuth stations, tolerably well distributed over the whole extent of the arc. The latitudes, as were those of the arc of parallel, were corrected for height of station or curvature of the vertical and for variation of pole according to Dr. Chandler's and Dr. Albrecht's researches. The same scrutiny as before has been extended to the deflections of the vertical, both regional and local. Partly on account of avoiding unnecessary labor, but principally on account of the crowding together of astronomical stations in certain very limited localities, and all of them, therefore, partaking of the deflections characteristic of this area, the total number of astronomical stations admitted into the final equations for the determination of the best spheroid were thirty-six for latitude, fourteen for longitude, and thirty-four for azimuth, or eighty-four conditions in all.

These eighty-four differences between the astronomical and geodetic results constitute the data needed for a new determination of a spheroid; next the functional relations between the positions of these stations upon the reference spheroid to the earth's equatorial radius and to the compressions of the polar axis had to be established.

The final normal equations contain, therefore, four unknown quantities, viz., the correction to the meridional-deflection of the vertical at the initial or reference station of the oblique arc; second, the corrections to the deflection of the vertical, in the plane of the prime vertical at the same place; third, correction to the equatorial radius of the reference spheroid; and, last, the correction to its compression.

In the combination of conditional equations arising from observations of a different nature, the question of their relative weights must be considered. In the present case, four assumptions were made, and the consequent normal equations solved, viz., for equal weights, for weights one-half, one-third and one-fourth to the azimuth equations, the latter being necessarily inferior to the equations derived from latitudes and longitudes. A comparison of these four results showed that it was of small consequence which of these hypotheses was finally adopted, since the corrections to the equatorial radius of the reference spheroid were practically the same for any of these hypotheses, and nearly the same could be said of the resulting compressions. The weight one-third to each of the azimuth equations was finally decided upon, and the resulting dimensions of an osculating spheroid were found to be: Equatorial radius, 6,378,157 ± 90 meters; compression 1/304.5 ± 1.9. The equatorial radius, therefore differs but 49 meters from Clarke's value of 1866 adopted on the survey, while the Besselian value is apparently too small by 809 meters. On the other hand, the compression or the ratio of the difference of the equatorial and polar semi-axes to the former is in favor of Bessel's spheroid, of which the compression is 1/299.2; that is, one more closely approaching a sphere.

In the present state of our knowledge there is no reason to suppose that the curvature of the northern part of America differs any more from that of a general spheroid derived from arcs of all kinds so far measured than local ones in either hemisphere differ among themselves.

* Abridged from a paper on recent contributions by the United States Coast and Geodetic Survey to our knowledge of the earth's shape and size, by Mr. C. A. Schott, in The National Geographic Magazine, New York.

† U. S. Coast and Geodetic Survey; H. S. Pritchett, superintendent. "The Transcontinental Triangulation and the American Arc of the Parallel. By C. A. Schott, assistant, Coast and Geodetic Survey, Washington, D. C., 1900.

A NEW TEST FOR HUMAN BLOOD.

IN the Deutsche Medicinische Wochenschrift of February 7 Stabsarzt Dr. Uhlenhuth describes some experiments which he has made with human blood, and also with that of a number of the lower animals, the result being that he believes that he has discovered a specific reaction for human blood, and also for that of the common fowl, the horse, and the ox. The process of testing for ox blood is described by him at length as follows: At intervals of from six to eight days about 10 cubic centimeters of defibrinated ox blood were injected into the peritoneal cavity of a rabbit, and after about five such injections the blood serum of the animal was fit for use.

In the next place samples of the blood of a number of different animals were diluted with about one hundred times as much ordinary water, making pale red solutions of about an equal depth of color. The insoluble stroma was removed either by subsidence or filtration. Of each of the clear solutions thus obtained about two cubic centimeters were put into test tubes of about a quarter of an inch in diameter, and then mixed with an equal quantity of a solution containing 1·6 per cent common salt—i. e., twice the strength of physiological salt solution. It is essential to use this particular salt solution, for the normal serum of the rabbit mixed with plain water gives rise to a turbidity which might interfere with the recognition of the specific turbidity. With physiological salt solution the addition of rabbit's serum never causes turbidity.

Dr. Uhlenhuth employed in his experiments both human blood and also that of the ox, horse, ass, pig, sheep, dog, cat, stag, fallow deer, hare, guinea pig, rat, mouse, rabbit, common fowl, goose, turkey cock, and pigeon. To each of the test tubes there was now added from a tube drawn to a fine point six or eight drops of the serum of the rabbit which had been injected with the blood of the ox, whereupon there was seen in the solution of ox blood a distinct turbidity which was very evident by transmitted sunlight. The contents of all the other tubes remained perfectly clear. In course of time the turbidity increased, and ultimately a copious flocculent deposit fell to the bottom. Normal rabbit's serum causes no turbidity in solutions of ox blood. By the addition of a few drops of serum from the injected rabbit it was therefore possible to recognize ox blood.

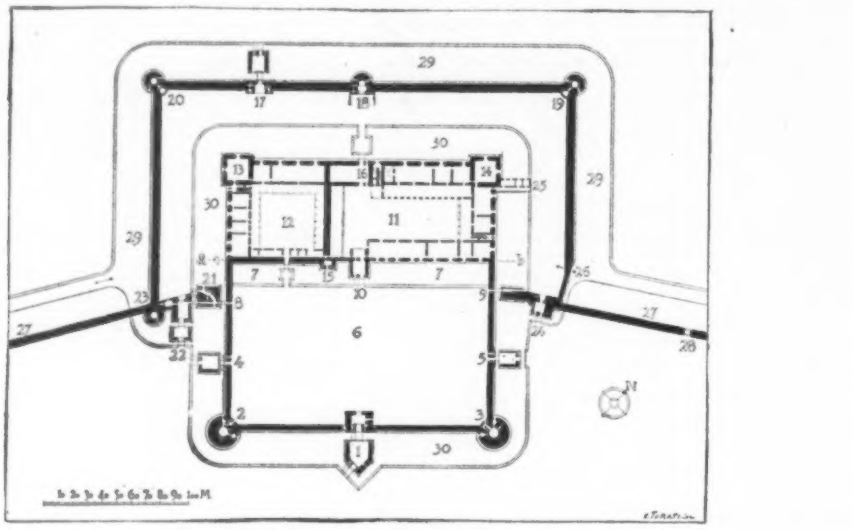
In a precisely similar manner injections of human blood were given to rabbits, and serum from the animals was added to the nineteen specimens of blood above mentioned, the result being that the solution of human blood, and that alone, became turbid and threw down a deposit. All the other solutions remained perfectly clear. Normal rabbit's serum causes no turbidity in solutions of human blood. This reaction, therefore, enabled human blood to be distinguished with certainty from the other kinds of blood above mentioned.

The reaction was extremely delicate, only traces of blood being required for the determination of the species of animal to which it belonged. By it Dr. Uhlenhuth succeeded in recognizing samples of human blood, ox blood, and horse blood, which had been allowed to dry on a board, and after four weeks were dissolved in physiological salt solution for the purpose of examination. His experiments were made in the Hygienic Institute of the University of Greifswald. If his conclusions are verified, the reaction will obviously be of great use in medico-legal inquiries.—The Lancet.

The castle of Chillon, immortalized by Byron, has been restored, and parts of it long unknown have been explored. Later work has been removed, revealing fine lanceolate windows, fireplaces, paintings, etc.

THE RESTORATION OF THE CASTLE OF MILAN.

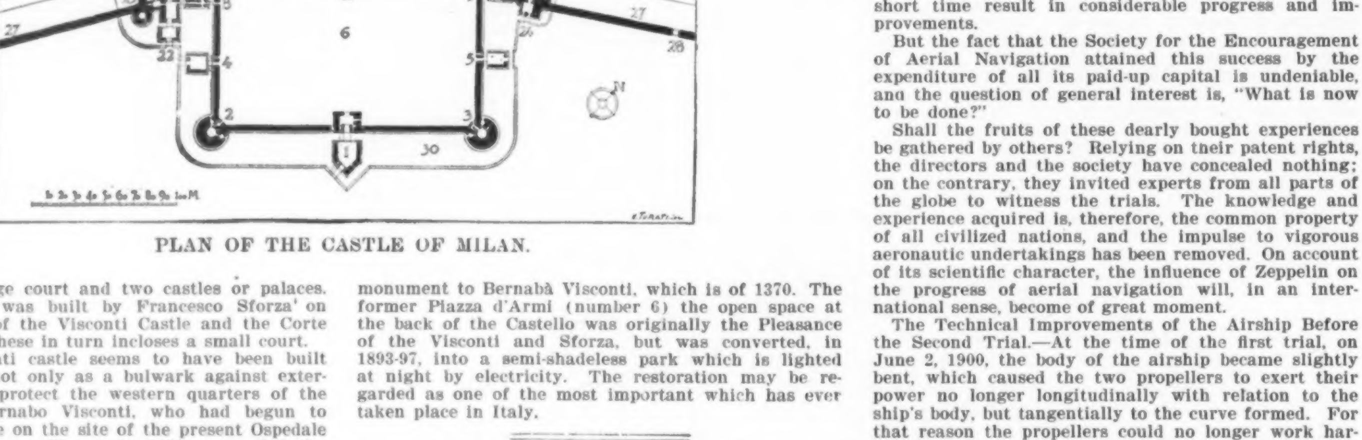
In 1893 began the restoration of one of the most interesting buildings in Europe, the castle of the Visconti and Sforza, at Milan, Italy. It was originally built in 1368, by Galeazzo II. Visconti, on the city wall adjoining the old Porta Giovia. It was destroyed by the Ambrosian Republic in 1447, and was rebuilt and enlarged by the Sforza about 1450. In 1893 its restoration was begun in the fifteenth century style from the plans of Luca Beltrami, a celebrated Italian architect. It has been fitted up for the reception of municipal collections, and the restored structure has just been opened to the public. The rectangular building has four-cornered turrets and a curtain wall contain the numismatic collection, the archives of the city for the study of the history of Lombardy, and a museum with a collection of patriotic objects from the time of the Cisalpine Republic down to the present day. The Torre di Bona di Savoia (number 15) is 165 feet high, and is shown in one of our engravings. To the right is the new palace of the Sforza, with Gothic windows and an imposing gallery of defense. In the south angle of the Ducal Court (number 14) is the Loggetta, a graceful Renaissance structure from the time of Galeazzo Maria. On the northeast side is a baroque gateway of the time of Philip III., surmounted by the arms of the Visconti and the Sforza. Most of the rooms on the ground floor are devoted to an archæological museum and our engraving represents the



PLAN OF THE CASTLE OF MILAN.

comprising a large court and two castles or palaces. The "rocchetta" was built by Francesco Sforza on the foundations of the Visconti Castle and the Corte Ducale; each of these in turn incloses a small court.

The old Visconti castle seems to have been built by Galeazzo II. not only as a bulwark against external foes, but to protect the western quarters of the town against Bernabo Visconti, who had begun to erect a new castle on the site of the present Ospedale Maggiore. Francesco Sforza, in 1450, persuaded the people to rebuild the stronghold that they had but a few years before razed to the ground amid universal jubilation. The forbidding character of the structure was somewhat modified by a tower erected by Filarete on the side next the town. This was, however, destroyed by an explosion of gunpowder in 1521. Behind the castle lay an extensive deer park. Galeazzo II. began to fit up both palaces with great luxury and summoned the great painters and sculptors of Lombardy to his aid. Bramante and Leonardo da Vinci co-operated with him in beautifying the castle, although the latter's design for rebuilding the main façade was never executed. An abrupt end was put to this brilliant period by the French invasion. In 1552-70 the castle was surrounded by six bastions and separated from the new town walls by a broad moat. Throughout all the Spanish and Austrian domination, it formed the focus of all the struggles for the possession of Lombardy. The republican monument to Bernabò Visconti, which is of 1370. The former Piazza d'Armi (number 6) the open space at the back of the Castello was originally the Pleasance of the Visconti and Sforza, but was converted, in 1893-97, into a semi-shadeless park which is lighted at night by electricity. The restoration may be regarded as one of the most important which has ever taken place in Italy.



FAÇADE OF THE NEWLY RESTORED CASTLE OF MILAN.

movement of 1796 incited the Milanese to a repetition of the events of 1447, but it was not until 1800 that Napoleon ordered the destruction of the fortifications. The castle was converted into barracks, the pleasure garden became a drill ground, and on the site of the Spanish bastions and rampart arose the spacious Foro Bonaparte, now partly built over. In 1886 it was decided to rebuild the castle, which was evacuated by the troops and turned over to the city.

The circular eastern tower, which is faced with cut stone, has been rebuilt to its original height of 100 feet, as shown in our engraving, and is now used as a reservoir for drinking water. The south tower or gateway of the Filarete (number 1 in the plan) has not yet been rebuilt, and garden between the towers also awaits restoration. To the left of the Court is the unpretending Rocchetta (number 12), which has lost almost all of its artistic decoration. One of the rooms contains the remains of a fresco by a painter of the school of Leonardo da Vinci. The other rooms

BALLOONING OVER THE BALTIC.

An international balloon expedition started from various places on the Continent on January 10. The German balloon was manned by Dr. Berson, of the Meteorological Institute, and First Lieutenant Hildebrandt, of the aeronautic detachment, Berlin. They happily succeeded in crossing the Baltic, this being the first passage by a balloon. After a small, unmanned balloon, with self-registering apparatus, had been sent off from the Aeronautic Observatory at Kegel, just before sunrise, and had descended a few hours later in the north of the Province of Brandenburg, the manned balloon ascended at about 8:45 o'clock from the Tempelhof Common, carrying two aeronauts. It contained about thirteen hundred kilometers of gas, and was supplied with all the necessary scientific apparatus. To facilitate breathing in the higher regions of the air, a bottle containing five hundred liters of oxygen was also taken. A light breeze was blowing as the balloon passed over Northern Berlin about two hundred meters high, and presently a brisk north wind sprang up, taking the balloon along at a velocity of about forty kilometers an hour, at an elevation of about a thousand meters, to Mecklenburg-Strelitz and on to Pomerania.

At 1:17 P. M. the adventurous balloonists found themselves near Stralsund, and, as the wind was still northerly, it was resolved to risk the passage of the Baltic, which was presently seen extending "like a white-flecked leaden waste" far beneath them. The Island of Rügen, which was soon afterward passed, presented an exquisite panorama. The higher the balloon ascended, the more agreeable the temperature became; the thermometer registering 8 degrees Celsius, at a height of 1,600 meters. About 3:30 P. M. the middle of the Baltic was reached, the coast of Germany appearing like a streak of gray against the clear sky. A little while later the travelers witnessed a magnificent sunset at a height of 2,000 meters, "the sun sinking like a red ball of fire into the lurid waves."

At 4:30 P. M. the Swedish coast was reached, and Trelleborg lay before them. The balloon then passed over Malmohus and Landskron, in the twilight, at an elevation of 3,000 meters, the aeronauts getting sight of the revolving lights on the coasts and harbors of Sweden and Denmark. After the balloon had traveled about four and a half hours over solid ground in Sweden, a dense fog set in, and the aeronauts decided to descend. It was 8 P. M., and they were traveling over a quite unknown country in the Province of Smaaland. The descent took place near the village of Hoga Hiltan, and was happily accomplished without assistance. They now hid the balloon in a wood, and went to a small farm in the neighborhood, returning to Germany the following morning.

THE TERMINATION OF THE TRIALS OF COUNT VON ZEPPELIN'S AIRSHIP.*

By H. W. L. Moedebeck.

In a general meeting, held November 15, at Stuttgart, the Society for the Encouragement of Aerial Navigation (Gesellschaft zur Föorderung der Luftschiffart) discussed the advisability of its dissolution. The results attained by the Zeppelin trials have not been unfavorable. In brief, it has been conclusively demonstrated that by following the plan proposed by Count von Zeppelin it will be possible to navigate the air. Although for the present we may have to moderate our demands for speed, nevertheless it is the conviction of all experts that pertinent developments will in a short time result in considerable progress and improvements.

But the fact that the Society for the Encouragement of Aerial Navigation attained this success by the expenditure of all its paid-up capital is undeniable, and the question of general interest is, "What is now to be done?"

Shall the fruits of these dearly bought experiences be gathered by others? Relying on their patent rights, the directors and the society have concealed nothing; on the contrary, they invited experts from all parts of the globe to witness the trials. The knowledge and experience acquired is, therefore, the common property of all civilized nations, and the impulse to vigorous aeronautic undertakings has been removed. On account of its scientific character, the influence of Zeppelin on the progress of aerial navigation will, in an international sense, become of great moment.

The Technical Improvements of the Airship Before the Second Trial.—At the time of the first trial, on June 2, 1900, the body of the airship became slightly bent, which caused the two propellers to exert their power no longer longitudinally with relation to the ship's body, but tangentially to the curve formed. For that reason the propellers could no longer work harmoniously. As the longitudinal axis had been bent downwardly, the airship inclined upwardly in its flight, a movement which, at proper moments, had to be counteracted by reversing the engines.

Count von Zeppelin therefore replaced the rather shaky and unsafe platform between the two cars by an I-beam, which he rigidly secured by means of stays to the two lower longitudinal beams. Thus he formed beneath the airship a substantial keel. On the lower flanges of the I-beam or platform, and between the two cars, moved the blocks for the sliding weight, which then weighed 150 kilos (100 kilos was the former weight), and which hung down only to the bottom of the car, whereas formerly they were suspended 26 meters. The question whether by this arrangement the positive center of gravity, which was thereby considerably raised, would impair the stability was certainly warranted. The results of the trials, however, proved the contrary. The sliding weight could now be moved 60 meters back and forth, and the sliding mechanism itself was of so durable construction as to dispel all fear of its injury.

On the platform strengthened by the I-beam it was possible to pass from one car to another with greater safety than was possible on the old shaky passageway. Furthermore, the weight was increased and space acquired under the two ends of the airship body. Formerly the blocks of the slideway ran out on these guides, but as the slide weight now runs between the two cars, those parts were no longer necessary.

Thus space was acquired to place the two rear rudders, one back of the other, closely to the car, whereas formerly they were attached on each side of the balloon body at about the height of the center axis. By reason of this arrangement the rudder ropes could be considerably shortened, hence lessening the chance of their being caught. It had been a prominent defect in the former arrangement that an inclination of a

* Translated from Prometheus.

rudder resulted in impounding the air on one side and offering no resistance on the other side. This defect was overcome.

In front of the forward car a new horizontal rudder was mounted, in order to keep the ship in longitudinal trim, as well as to assist in reaching desired heights.

The three forward rudders and the one at the extreme end of the ship were controlled from the forward car, while the other rear rudder was to be used only as required and at command.

The distribution of the water ballast had been more judiciously arranged, also the mechanical devices for discharging the same had been considerably improved. Lastly, the silk on the under side of the balloon was replaced by cotton goods, as the silk proved itself not durable enough, though it was known that the use of the heavier goods was not an improvement. The necessity of the substitution, as well as the high cost and uncertainty of the timely delivery of the silk, was the reason for the substitution.

The Accident on September 25.—Count von Zeppelin energetically undertook the above-mentioned improvements so as to repeat the trials while the weather was still favorable. On September 24 everything was tested and ready for the ascent; the guests who were invited had arrived, and early on the 25th the gasbags were to be inflated, and the trial was to take place when the proper conditions prevailed. However, during the night of September 24-25, two of the suspending members gave way, causing the body to bend and to touch the floor of the housing. This bending naturally led to necessary repairs, new expenditures, and a further delay of the trials. Upon examination, it was found that the movements of the balloon housing on the water caused a constant friction and a gradual wear of the rivets on the suspension members.

It was an interesting feature of the accident that the aluminium framework was only bent, and not broken.

The Trial on October 17.—The repairing of the craft was prolonged to October 14. On account of the unfavorable weather, the inflating of the gasbags could be commenced only on the morning of October 17. The bags were inflated without accident. At four in the afternoon the filling had been completed, and after the occupants took their places in the cars everything was ready for the ascent.

In the forward car was Count von Zeppelin as aeronautical guide, and First Lieutenant von Krogh, of the 24th Holstein Field Artillery, as aerostatic guide, and Engineer Burr to look after the motors. In the last car were the explorer, Eugen Wolf, and the machine constructor, Gross. Twelve hundred kilos of water ballast were carried, and were so well distributed that a possible bending of the longitudinal axis was not to be feared by reason of the load. There still remained, however, a buoyancy of 70 kilos, with which the desired height of 300 meters could be reached.

The weather was calm. The wind was blowing from the northeast, with an average velocity of four meters per second.

At the command "Start!" the airship arose majestically, at 4:45, in a horizontal position.

The incidents of this trial trip are described by Count von Zeppelin, as follows:

"The airship remained almost continually at a height of 300 meters above the lake. Under these circumstances, the speed of the vessel might have been tested by a prolonged straight-away and return sail on the current of the winds. This, however, was prevented by the rearmost rudder catching in the balloon envelop and remaining in a 'port' position. When the straightaway sail was to be made the air ship swung to port. Until the cause of this was ascertained and counteracted by means of the other rudders, the airship got so close to land as again to necessitate a complete turn to the left and backing at intervals.

"When the craft again came lakeward the day was so far advanced that it became advisable to steer toward the housing so as to effect a landing there.

"Owing to lack of experience, however, the turn was made too soon. The side wind brought the craft beyond the housing, so that the whole of the above-described maneuvers of turning to the left and occasional backward movements had to be repeated. This time the course to the housing was well directed, and in a long, slightly inclined reach we neared land. Suddenly, however, the airship rapidly inclined more and more toward the front, although with all haste every possible preventive measure was put in use—adjusting the elevation rudder upwardly, turning back the winch of the slide weight, throwing out ballast at the front, letting off gas in the rear, and finally, stopping and reversing the motors.

"After 23 seconds the craft, still sailing rapidly, struck the water. The landing was effected at 6:05 P. M.

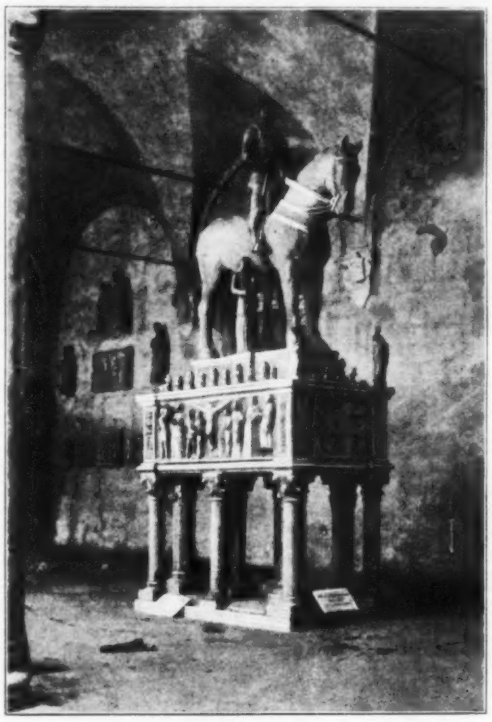
"With a speed judged to be about 10 meters per second, the airship, in the inclined position, struck the water bow first, thus relieving the front car of the shock which might otherwise have snapped its supporting rods. The rear car thereupon settled slowly.

"The trip proved that alighting on water presents the safest guarantee to both the airship and its occupants. In the present case an accidental escape of the gas of balloon No. 3 took place—a loss of 700 cubic meters of gas. As it later turned out, the valve-lever became caught, thus opening the valve. The result was that the equilibrium was destroyed, which, with all the available means could not be counteracted. Had the accident happened on land, under such circumstances there would have been a catastrophe, as the bow of the airship would have been damaged, and the forward car also would have received its share. In general, it has again been confirmed that large balloon surfaces, to a certain extent, act like a parachute, thus deadening the shock.

"The damage sustained was inconsiderable. It was to be regretted that the return sail toward the housing and against the wind, which was progressing so favorably, was so prematurely interrupted."

The absolute speed attained by the airship, the Count von Zeppelin supposes to have been 8 meters per second. Similar statements have been made by Prof. Hergesell, Dr. Slade and Lieut.-Capt. Bethge. The exact result can be obtained only after the course taken by the airship has been geometrically plotted. The duration of the trial was 1 hour and 20 minutes.

Technical Improvements of the Airship Before the Third Trial.—First, the inconsiderable damage was repaired. Furthermore, the cause of the same, as well as the catching of the valve lever, were ascertained and remedied. Lastly, the steering gear was simplified. Of the forward rudders, the uppermost was removed, and of the rear rudders the one nearest the



MONUMENT OF BERNABÀ VISCONTI.

rear car was removed. The rearmost rudder was placed so low that it could no longer come in contact with the balloon envelop. On October 20, in the afternoon, all this work was completed, and on the 21st the filling of section 3 and the replenishing of the others could be begun. Unfortunately, chemically prepared hydrogen, of doubtful purity, was hastily prepared.

Third Trial, October 21.—The airship had lost much in lifting capacity. But it was now certain that the various cells admirably retained the gas. It was also found that there was less loss from the inner and outer skins than from the deficient closing of the safety valve.

The casting-off on October 21 showed, therefore, a buoyancy of but 20 kilos, and a ballast of only 30 kilos in each car. This unfavorable distribution of weight on both ends of the airship caused a strain which resulted in the longitudinal axis bending upwardly in the center, and also brought with it all the disadvantages encountered on the first trial.

The weather was rainy, the wind mild, averaging 2 meters per second. At 5:02 in the afternoon the airship began its ascent. The particulars are best set forth by the words of the Count himself: "It was totally contradictory to the aeronautical theories to succeed in causing so large an airship to ascend with so little ballast. However, from the experience acquired on the two previous trials, this ascent could be risked, and the success of the experiment has, of course, fully warranted this experiment."

The ship was kept fully under control. The rudders were easily operated, and although there were only two side rudders—one in the front and one in the rear—against four formerly used, nevertheless the airship responded promptly to their pressure. At first a large curve was described to port and then another to starboard, and then, since night was fast approaching, a landing was made near the housing, at 5:25 P. M. At 6 o'clock the uninjured airship was again in the housing.

Conclusions.—The airship, based upon the experiments of Schwarz's craft, was entirely new and good, and was built in the aluminium works of C. Berg. Particularly commendable was the compartment construction, and to this arrangement was due the stability of the airship. It was the stability of an airship built according to Zeppelin's plans, that his opponents not only doubted, but directly denied. To impart stability to a body 128 meters long, without compartments, certainly would have been an impossibility. Every upward tendency of the balloon would have forced the gas to the upper end, resulting in the bursting of the long cylinder.

Most surprising was the fact that the center of gravity of the entire system remained low enough, even after the slide weight had been rearranged from 26 meters to 2 meters below the balloon body. The increase in weight of the latter by 50 kilos had little significance. A decided advantage of the new arrangement of the sliding weight on the I-beam or platform was the readiness and security with which it could be moved. It was no longer lifted, but shifted back and forth on the flanges of the rigid support.

The truss construction ought, in the future, to be made stronger to avoid the bending of the longitudinal axis—an easily solved problem after the practical experiences have now been made. The material supplied by C. Berg has, in view of the many damages sustained, proved to be good; it will not break or crack, but simply bend. The aeronautical advantage of this lies in the fact that, in case of a mishap or collision, there are no sharp points, etc., to pierce the delicate gasbags.

The motors, with their transmission gearing, ran smoothly, and on no trial was there an occasion of fault to be found with them. The four-bladed screw propellers have also fully satisfied the expectations of the Count von Zeppelin. The attained absolute speed of 8 meters per second is an advance in general. A greater speed could not be attained with the present means. (See SUPPLEMENT No. 1295.)

The difficulty of providing light and powerful motors is not insurmountable. For an airship of the dimensions of Count von Zeppelin's to acquire an absolute speed of 10 miles, a 60-horse power motor would be needed, and for a speed of 15 miles a 125-horse power motor would be required.

These are technical problems which already have been partially solved for flying machines by such men as Maxim and Ader.

TORRE DI BONA DI SAVOIA, CASTLE OF MILAN.

The radius of action of the airship is not exactly determinable. In this case little can be said, as this airship must be considered as an experimental craft. The voluminous experience and knowledge acquired shows that the purity of the hydrogen gas in the bags, as well as the careful manufacture of these bags, is a matter which must be given greater attention. These are the prime factors relating to the radius of action, and on these depends the necessary power for the ascent. However, to remain long in the air and to carry much fuel require a surplus of buoyant power. Therefore, a decrease in weight and, under the circumstances, an increase of the dimensions of the airship might be taken into consideration.

As to the steering gears, the simplest proved the best.

The landing on water with such a rigid airship is the only possible landing that can be safely and easily effected.

[Continued from Supplement, No. 1318, page 21133.]

ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

By Dr. J. A. Fleming, M.A., F.R.S., Professor of Electrical Engineering in University College, London.

In the case in which the resonator is placed with its plane lying in the plane containing the axis of the radiator and the base line, the distribution of electric displacement in disturbed, as already explained, by the metallic circuit of the resonator, and the advancing wave surface of displacement is distorted so that in crossing the spark gap of the resonator the displacement has a compound parallel to the spark axis of the resonator, and therefore the conditions are such as to be favorable to the production of at least feeble sparking.

Hertz's most famous discovery with the above-described simple resonator was the proof he was able to give of the existence of stationary electric waves set up in a dielectric bounded by a sheet of metal. He attached to his induction coil terminals a radiator composed of two square sheets of metal 40 centimeters in size, each having a wire 39 centimeters long attached to it ending in a brass ball. These plates were arranged with the rods in one line and the balls about a centimeter apart, the direction of the rods being vertical. As a resonator he used a circular wire 35 centimeters in diameter with the ends nearly meeting and furnished with spark balls. A large sheet of metal was set up at the end of the room, and the radiator with axis vertical placed at the opposite end. The resonator was then held with its plane parallel to the metal sheet and its spark gap parallel to the spark gap of the radiator.

Under these conditions, if held near the metal sheet, no sparking occurred, but if moved away from it sparks were seen, and at a certain distance these sparks had a maximum brilliancy, but if the resonator was removed still farther from the metal sheet a position could be found in which the sparks again ceased.

All along the base line, therefore, perpendicular to the metal sheet, it was found that there were positions of maximum and minimum sparking indicating a periodicity in the distribution of electric force in that space.

A very important discovery in connection with this phenomenon was made by Sarasin and De la Rive (Comptes Rendus, March 31, 1891), who found that the distance between two non-sparking places essentially depended upon the size of the resonator and was approximately equal to four times the diameter of the circular resonator.

The earliest view taken of the effect was that the radiator creates stationary dielectric waves of definite wave length, and that the resonator indicates this wave length by sparking when held as described at places of maximum electric force. But it is found that the size of the radiator very little affects the result.

Another hypothesis was that the radiator sends out waves of all wave lengths, resembling therefore white light, and the resonator picks out and responds to its own particular wave length. But this hypothesis is not justified by any facts. The most probable ex-

Fig. 6.

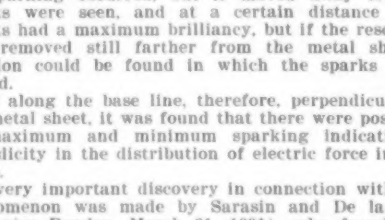
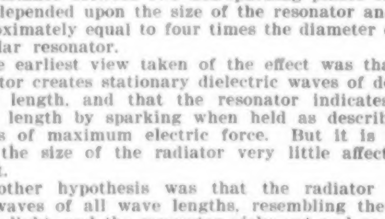


Fig. 7.



Diagrams representing feebly damped (Fig. 6) and strongly damped (Fig. 7) Electrical Oscillations.

plantation was that given by M. Poincaré, in 1891, and also by Prof. J. J. Thomson ("Recent Researches on Electricity and Magnetism," p. 402). The radiator, as shown by Bjerknes, is a very strongly damped system, and at each discharge hardly makes more than a dozen oscillations, even if so many, before its electrical vibrations are damped out (see Figs. 6 and 7).

Suppose the resonator then held at a distance from the metal wall equal to a quarter the wave length corresponding to this particular resonator, then as the electric force passes over it, it will create a displacement between spark balls. This displacement travels on, is reflected from the wall, and returns. If it returns at such a moment as to assist the displacement, then being made between the spark balls of the resonator, the amplitude of this displacement is increased and a succession of such assistances will break down the insulation of the air and a spark will occur. It is clear, therefore, that his reinforcement of the displacement amplitude will occur when the distance of the resonator from the metallic wall is a quarter of its own wave length. Sarasin and De la Rive used resonators of various diameters (D) as shown in the table below, and measured the distance $\frac{1}{2}L$ between places of maximum sparking in the resonator.

Table I.

D	4D	Distance between two adjacent points of maximum sparking = ½L.
100 cms.	400 cms.	406 cms.
75	300	282
50	200	222
35	140	152
25	100	120
20	80	86
10	40	38

Accordingly the positions of the resonator when the maximum sparking takes place in its air gap reveal, not the wave length of pre-existing stationary waves, but the oscillation period or wave length corresponding to the resonator itself. Nevertheless they prove the existence of stationary dielectric waves in the space between the metal sheet and the radiator.

Prof. J. J. Thomson notes one point as yet unexplained. The above table shows that the wave length is eight times the diameter of the resonator. If this is really the wave length of free oscillations of the radiator system we should have expected it to be equal to 2π times the diameter of the circular radiator and not to eight times.

By making an estimate of the vibration period of the oscillator and measuring the wave length or double distance between two maximum sparking places as the resonator was moved along the base line, Hertz was able to make an approximate estimate of the velocity of propagation of these electric waves, and show that it was of the same order as that of light. Since his time more accurate work has confirmed the above estimate, and shown that there is an almost absolute identity between the experimentally-determined velocity of light through air and that of electrically-produced waves through the same medium. Hertz also showed that these waves were guided in direction by metallic wires.

Space will not permit us to enter into a full discussion of these experiments, but the reader must be referred for details to other sources of information.*

The exceedingly careful experiments of Messrs. Trowbridge and Duane on the propagation of electric waves are, however, so valuable a contribution to the subject that it is desirable not to omit reference to them.†

In studying the propagation of electric waves along wires experimentalists have generally employed some modification of conductor systems usually called the Lecher arrangement. In this arrangement a Hertz oscillator consisting of two plates, as already described, is attached to the secondary circuit of an induction coil, and two other insulated plates are placed parallel and opposite to these respectively, but separated by a little distance, the dielectric being air or any suitable solid. To these last plates are attached long wires which extend parallel to each other through space. When the coil is in operation and sparks passing between the primary spark balls, the rapid oscillation of potential of the plates of the Hertz oscillator creates similarly rapid changes of potential of the secondary plates, and hence produces electric oscillations in the long wires. The condition of these wires when of suitable length is then as follows:

At certain places there are alternations of potential which may be called potential loops, and at other intermediate positions there are potential nodes or places of minimum potential variation. There is also a variation of current in different parts of the wires. In some places the current has a maximum value and in others a minimum. Accordingly, when we are dealing with the propagation of these rapid oscillations along wires, it is curious to find that the current has not always the same strength in different parts of the same wire. Strong currents may exist in some places and yet little or no current at all in other parts of the same continuous wire.

If the ends of the wire are free or open, the current is necessarily zero at the free ends. In all these cases the places of maximum potential variation are those of minimum current or vice versa. There are many ways in which this distribution of current and potential along the wires of the Lecher apparatus can be explored. If the variations of potential are of sufficient amplitude, the position of the nodes and loops can actually be seen in a dark room by the unequal distribution of a luminous glow surrounding the wire, bright at some places but less bright or absent at others.

Hertz studied the propagation along wires by placing his resonator with spark gap parallel to the wire along which the waves were traveling, and moving it to different positions. If, for instance, a wire attached to a plate placed opposite to one of the plates of a Hertz radiator is stretched out parallel to the base line, and if a Hertz resonator is placed with its center on the base line and its spark gap parallel to this wire, then if the plane of the resonator is at the same time perpendicular to the plane containing the spark axis of the radiator and the base line, we have seen that under these conditions the direct action of the radiator produces no sparking in the resonator. If, however, the resonator is placed in this position and moved along with its spark gap parallel and near to the stretched wire, small sparks are seen at the resonator balls at some places, but not at others, thus showing a variation in the distribution of potential at different places along the stretched wire.

Another method, due to Lecher, is to bridge over the wires with a vacuum tube, which can be slid along into different positions. The vacuum tube may have in it rarefied air with a trace of turpentine vapor, or it may be made of some fluorescent glass. In any case, the tube is found to become luminous in some positions and not in others. The vacuum tube may be placed across the open ends of the wires, and these may be bridged across by a metal wire which is slid along into various positions. In some positions of the bridge the vacuum tube will glow and in others it will not.

A third arrangement is to employ a bolometer. If fine insulated iron wires are twisted round a wire in which oscillations are set up, and if these iron wires form part of one arm of a Wheatstone's bridge, then it is found that the oscillations of current in the wires induce others in the iron wire which heat it and change its resistance; the balance of the Wheatstone's bridge is thus upset. By sliding the iron wires along the wires conducting the oscillations it is possible to discover the places of maximum and minimum current in these last conductors.

A fourth arrangement is by the use of a quadrant electrometer having a needle connected to one pair of quadrants. By the use of this idiostatic electrometer we can explore the distribution of potential along the wires. These and several other methods enable us to measure the wave length of the oscillations of potential or current along wires.

In the experiments of Messrs. Trowbridge and Duane referred to above, the Hertz oscillator consisted of a pair of sheets of tin foil separated by a very thick sheet of ebonite. These sheets of tin thus forming a condenser, were connected to spark balls and formed a primary oscillator. Outside these sheets of tin were placed other sheets of ebonite, and then two more tin foil plates connected by a wire laid out in a long rectangular form. At the far end of this secondary circuit was a small spark gap with pointed cadmium terminals. When oscillations were set up in the primary condenser circuit, sympathetic oscillations were excited in the secondary circuit, and by adjusting the length of wire in the secondary circuit it was brought into resonance with the primary. It was then found that there was a current node at the central point and ventral or maximum current points at other places along the two parallel sides. The positions of these places on the wire were determined by the bolometer.

The vibration period of the secondary circuit was determined by photographing the secondary spark. Hence observations gave the frequency and the wave length. The mean of a very large number of observations with this apparatus enabled Messrs. Trowbridge and Duane to prove that the velocity of the waves along the wires was equal to 3 by 10^{10} centimeters per second, that is the same as the best determination of the velocity of the light in air.

The material of which the wires are made, as long as it is not magnetic, has no effect upon the result. These facts show that the effects must really be due to the propagation of dielectric waves in the space between the wires, and experiment shows that their velocity is sensibly the same as that of free electric waves in space. In other words, the wires only guide the waves.

The distribution of electric force or displacement is such that it is perpendicular to the surface of the wires, and the magnetic force or flux is perpendicular to the electric displacement.

Before proceeding to discuss the special properties of electric radiation, it will be convenient to make a brief allusion to other methods of detecting electric waves.

One of these, which has proved most useful in practice, is based upon the properties of aggregations or of metallic microphonic contacts of becoming changed in resistance by the impact of electric waves. The late Prof. D. E. Hughes undoubtedly proved in 1879 that a tube loosely full of metallic powder was by the action of an electric spark at a distance caused to pass from an electrically non-conductive to a conductive condition.* It was not, however, until 1891, when Prof. E. Branly described his experiments on the same subject, that the effect of electric sparks upon loose agglomerations of metallic particles was examined with sufficient care.†

The term "coherer," which was introduced by Dr. Lodge to describe a loose or microphonic contact between metal surfaces, balls, or points and plates, has passed into general use to describe any form of loose collection of metallic particles in a tube which is affected as regards conductivity by electric waves.

The chief property of such a loose or imperfect microphonic contact, whether between single pieces of metal or innumerable particles of metal, is that large variations of resistance can be made in a circuit containing it when the microphonic contact is exposed to the action of electric force.

It appears, however, from the experiments of Prof. Bose (see Proc. Roy. Soc. Lond., July, 1899, vol. 65) that this variation is not always a reduction in resistance. If the substances in loose contact are pieces of clean potassium immersed in paraffin oil, the action of the electric waves, according to Prof. Bose, is to produce an *increase* in resistance. This fact alone shows that we must be cautious in making theories as to the cause of the commencement of electric conductivity in these cases. Moreover, the same investi-

* Lecture delivered December 17, 1900, before the Society of Arts and published in the Journal of the Society.

* Hertz's original papers are published under the title of "Electric Waves," and have been translated into English by Prof. D. E. Jones. For a summary of Hertz's work see "The Alternate Current Transformer," vol. i., J. A. Fleming; also "Recent Researches in Electricity and Magnetism," Prof. J. J. Thomson; and "The Work of Hertz," by Dr. O. J. Lodge.

† Phil. Mag., August, 1895, or The Electrician, vol. 35, p. 712.

* For an account of Prof. Hughes' early work see Fahie's "Wireless Telegraphy," Appendix D; or Electrician, vol. 43, p. 40, May, 1899.

† For an account of the investigations of Prof. Eduard Branly on "The Electrical Conductivity of Discontinuous Conducting Substances," see La Lumiere Electrique, May 16, 1891; or Electrician, vol. 27, p. 221. Also Comptes Rendus, December 6, 1897, or Electrician, vol. 40, p 333; also Comptes Rendus, July 25, 1898, or Electrician, vol. 48, p. 87; also see Dr. Dawson Turner's paper on "Experiments on Electrical Resistance of Powdered Metals," Proceedings of the British Association, Edinburgh, 1892; or Electrician, vol. 29, p. 432.

gator has found that a sensitive tube made with certain powdered metals, such as arsenic, exhibits a different behavior to strong and weak electric radiation. A given radiator increases the resistance of powdered arsenic when the tube is within a certain critical distance, but reduces it if placed beyond that distance.*

It has been suggested that the phenomenon of the coherers of two metallic surfaces at first lightly but not electrically in contact, under the action of an electric wave is due to the creation of a large difference of potential between them, and that they are thereby drawn together and cohere.

It may be, however, that a chemical action between the metal particles and the dielectric in which they are immersed, when a gaseous liquid or solid, is an essential part of this change in resistance. Metallic particles embedded in solid dielectrics like gelatine or collodion can also be made to pass from an insulating to a conducting condition by the action of an electric wave.†

In the case of tubes partly full of loose metallic filings the nature and pressure of the atmosphere included in the tube undoubtedly exercises a great influence on its behavior under electric waves. The employment by Mr. Marconi of a good vacuum is unquestionably a factor in his production of an extremely sensitive and reliable detector.

It appears, therefore, that so far from an increased conductance being invariably the result of the action of electric force or a loose contact, it may either be an increase or a decrease. It will probably be found that when the matter is more fully explored these facts fit in with and explain many previously unintelligible phenomena.

Many years ago Edison invented an instrument which he called an electromotograph, and made it the foundation of his well-known chalk cylinder telephone receiver. He discovered that the friction and therefore the coherence between certain surfaces, such as a metal surface and a chalk surface moistened with solutions of certain salts, was greatly decreased by passing a current through them.

Neugshwender has discovered (see Electrical Review, vol. 44, May 26, 1899) that a film of moisture caused by breathing on a scratch made in a silver coating on a glass plate was sensitive to electric waves, the coherence between certain surfaces, such as a Ann., vol. 68, p. 92). In one case the resistance of the film was raised from 50 ohms to 90,000 ohms by the impact of electric waves, the scratch being 20 millimeters long and one-third of a millimeter wide. Contrary to expectation, the property was not destroyed by evaporating the film, and this led Neugshwender to suspect that metallic salts dissolved in the moisture had something to do with the phenomenon.

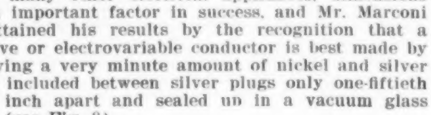
It may therefore prove to be the case that increase or decrease of conductivity in heterogeneous substances by the action of electric waves is not only a more or less universal phenomenon, but is a complex effect, and not explained sufficiently by christening the conductor a coherer.

In view of the fact that a marked increase in resistance is the result of the action of electric force on certain conductors, it might be better to abandon the term coherer as somewhat inapt in many cases, and simply call these substances sensitive to electric force or electric waves *electrovariable conductors*, denoting them positive or negative according as the conductance increases or decreases.

Accordingly, most powdered metals, loose metallic contacts, loose aggregations of carbon particles, and other substances, may be called *positive electrovariable* conductors, because they increase in conductivity by the action of an electric wave; whereas aggregations of particles of the alkaline metals, films of moisture on glass, certain films of metallic salts, and other substances, may be called *negative electrovariable* conductors.‡

In the next place, as regards the construction of these electrovariable conductors, it is impossible to describe a fraction of all the work that has already been done on them. No one has bestowed more minute attention to their practical construction than Mr. Marconi, and the result of his labors has been the evolution of a marvelously sensitive and certain instrument. As in many other electrical appliances, dimensions are an important factor in success, and Mr. Marconi has attained his results by the recognition that a sensitive or electrovariable conductor is best made by employing a very minute amount of nickel and silver filings included between silver plugs only one-fiftieth of an inch apart and sealed up in a vacuum glass vessel (see Fig. 8).

FIG. 8.



MARCONI COHERER TUBE.

In the case of these positive electrovariable substances the usual method of bringing them back again into a condition of high resistance is by an appropriately administered tap so as to disturb the small metallic particles and break down the connection between them.

There are other ways, however, by which a similar return to the high resistance condition can be effected. One of these is by heating, and another method in the case of magnetic particles such as those of iron or nickel, is the employment of an alternating or moving magnetic field.

For many laboratory experiments it is not necessary to place the metallic filings in a vacuum in making a sensitive tube. The following simple construction is one which I have found easy to make and reliable to use. Two small plates of silver are bent into the shape of the letter L, and then placed back to back separated by a small slip of celluloid or ivory a millimeter in thickness, in which is cut out a deep U-shaped notch. The silver and ivory slips are bound together with silk. The arrangement then forms a very narrow cell with silver sides and open at the top. A wedge of ivory or fiber fits into the open end of the cell and forms a lid. Into the narrow crevice between the two silver plates is introduced a very small quantity of nickel filings and the right amount determined by trial. The thin insulated wires are soldered to the L-shaped silver pieces. The whole arrangement is carried on an extension of the armature of an electric bell magnet which plays between two screw stops.

If a current is sent through the magnet suddenly, it attracts the armature and gives the cell carried on it a jerk which, when properly adjusted, is sufficient to bring back the nickel filings to a non-conductive condition.

A few trials with a small electric gas lighter and a galvanometer and cell in series with the sensitive cell are sufficient to enable one to adjust the quantity of nickel filings in the cell to the right amount.

So arranged, the cell becomes conductive when an electric spark is made near it, and is brought back to a non-conductive condition by sending an intermittent current through the electro-magnet and giving the cell a few jerks or shakes. Much of the success depends upon the adjustment of the right amount of filings and the limitation of the vibrations of the electro-magnet armature.

A sensitive cell of this kind properly constructed is marvelously sensitive to the passage over it of an electro-magnetic impulse. For many purposes it cannot take the place of a Hertz resonator. The sensitive tube responds apparently equally well to electric waves of all wave length. It is, so to speak, *electrically color blind*.

On the other hand, the Hertz resonator is as we have seen especially sympathetic to electric radiation, having a frequency equal to its own natural time period.

Turning then to the results of investigation with these and other electric ray detectors, we have in the first place to notice the proofs that have been given that the electric radiation sent out from a Hertz or similar oscillator resembles in all respects plane polarized light.

We are familiar with the fact that the light transmitted through a thin crystal of tourmaline, or either of the two rays transmitted and produced from one incident ray by Iceland spar, is in a condition in which it is non-symmetrical with respect to the direction of the ray. The ray transmitted by one tourmaline crystal is incapable of passing through a similar crystal placed with its axis at right angles to the first.

Moreover, this plane polarized light is susceptible of reflection, refraction, and of producing interference with other rays. Similar qualities characterize the electric radiation, and these can be demonstrated by remarkable experiments.

The ever-memorable achievement of Hertz was that he first threw open the entrance into this new and fertile field of inevstigation.

It is a difficult matter even to repeat Hertz's experiments on this subject in a laboratory, and almost impossible to show them to an audience. Nevertheless, the facts are so important, and an experiment shown is so much more valuable than a statement, that I have devoted much attention to devising apparatus suitable for lecture purposes by which the principal facts of electro-optics can be shown even to large audiences. For this purpose I have constructed a special form of radiator and receiver. The radiator consists of a zinc box with one end closed, but open at the opposite end. From the sides of the box protrude zinc tubes. In these zinc tubes are fixed ebonite tubes, each of which contains a rod of brass 4 inches long, ending in a brass ball 1 inch in diameter. The rods are attached to long spirals of gutta-percha covered wire, which fill up the rest of the ebonite tube.

The rods are so fixed that the balls are held about a millimeter apart in the interior of the zinc box. The outer ends of the wire spirals are connected with the secondary circuit of an induction coil. When the coil is in action sparks pass between the balls and create electric waves about 8 inches in wave length, which issue from the open mouth of the zinc box. The use of the wire spiral at the end of the rod is to prevent the waves from traveling out at the side tube.

The receiver consists of a similar box containing a simple form of nickel-filings coherer. The wires in connection with the coherer are brought out through a metal pipe, which must be screwed or soldered into the box. This pipe is a couple of yards in length, and leads to an open metal-box, in which is placed an electric bell, battery, relay, and relay battery, so joined up that when the metal filings in the sensitive tube become conductive the relay is traversed by a current and sets the electric bell in action. The sensitive tube is restored to non-conductivity by giving the receiver-box a smart knock with the fingers. The radiator-box is held on a stand, so that it can be placed with its axis at any angle.

Furnished with this apparatus, we can generate a nearly parallel beam of electric radiation, the wave length of which is only about 8 inches. By its aid we can follow out a series of demonstrations, proving, as Hertz first showed, that this radiation is capable of reflection, refraction, and interference, and that various substances are opaque to it and others transparent. Moreover, this radiation, he showed, was stopped by a grating of fine wires placed with their direction perpendicular to that of the electric force or axis of the radiator. Since Hertz's experiments were made many have traversed the same ground and gleaned much additional knowledge.

It is now well known that to produce successfully on a moderately small scale optical effects with electrical radiation, it is necessary to employ radiators of small dimensions.

Prof. A. Rhigi, in 1894, described investigations made with an oscillator consisting of two small metallic spheres, 3.75 centimeters in diameter, immersed in oil. These, when actuated by a large induction coil, produced electric waves 10.6 centimeters in length. The resonator consisted of a piece of glass silvered along a certain strip four centimeters in length, and one-fifth of a centimeter in diameter. Across the center of this strip a minute scratch was made, forming the spark gap, and a microscope was employed to observe the tiny sparks in this spark gap.

With this apparatus, or with another circular or ring-shaped resonator formed in the same way of silver deposited upon glass, Rhigi obtained electrical equivalents of all the familiar optical facts, the resonator acting as an eye to detect the invisible radiation. Since that, other workers such as Lebedew and Lampa have, by reducing the dimensions of the apparatus yet further, decreased the wave length of electrical waves to about four centimeters, and obtained electrical radiation the wave length of which is only fifty to sixty times longer than that of the longest heat rays which have been sifted out by repeated reflection from a luminous source of radiation such as the Welsbach gas radiator.

This electrical radiation penetrates easily through dielectric bodies. It is completely reflected from metallic surfaces, and is also more or less reflected from the surface of insulators.

These facts I can easily show to you with my apparatus. If the radiator-box and receiver-box are placed with their open ends toward each other and about a couple of feet apart, the axes being in the same straight line, we find that on pressing a key in the primary circuit of the induction coil the bell in the receiver circuit rings. If, however, a sheet of tin or tin foil or even of silvered paper is interposed the radiation is cut off. A sheet of perforated zinc, a wet duster, and even the human hand or body are found to be perfectly opaque. On the other hand, a slab of wood, paraffin, wax, pitch, glass, ebonite, leather, dry cloth, and all other insulators are transparent. Conductors of any kind are opaque. Among liquids, water, alcohol, glycerine, and amyl alcohol are also opaque, while paraffin oil, turpentine, bi-sulphide of carbon, and creosote are very transparent.

If we turn the radiator so that its open mouth is not directly toward that of the receiver we find that the receiver is not affected, showing that the radiation is not entering it. We can, however, reflect the radiation into the receiver by using as a reflector a sheet of metal, a wet cloth, the hand, or a sheet of glass. We can easily prove that this radiation obeys the optical law, and that the angle of incidence is equal to the angle of reflection. All good reflectors are opaque to the radiation. It is curious to notice how much of the radiation is reflected from a sheet of window glass, even although glass is a very good non-conductor.

By examining the reflection from dielectrics such as glass and paraffin, FitzGerald and Trouton were enabled to settle the long-disputed question as to the direction of the vibration in relation to the plane of polarization in plane polarized light.

According to Fresnel, the luminous vibration was at right angles to the plane of polarization; that is, to the plane of reflection when light was polarized by reflection; while, according to MacCullagh, it was at right angles to that plane.

(To be continued.)

CARBON PAPERS.

MANY copying papers act by virtue of a detachable pigment, which, when the pigmented paper is placed between two sheets of white paper, and when the uppermost paper is written on, transfers its pigment to the lower white sheet along lines which correspond to those traced on the upper paper, and therefore gives an exact copy of them on the lower paper. If the copying paper is coated with pigment on one side only, that is naturally made the lower side. If, however, it is pigmented on both sides, it is placed between two sheets of white paper, and the sheet to be written on is placed on the top of all. Two copies are thus obtained, one of which is reversed, but can be easily read by either of the two well-known devices.

The pigments used are fine soot or ivory black, indigocarmine, ultramarine, and Paris blue, or mixtures of them. The pigment is intimately mixed with grain soap, and then rubbed on to thin but strong paper with a stiff brush. Fatty oils, such as linseed or castor oil, may be used, but the grain soap is preferable. Graphite is frequently used for black copying paper. It is rubbed into the paper with a cotton pad until a uniform light-gray color results. All superfluous graphite is then carefully brushed off.

It is often required to make a copying paper which will produce at the same time a positive copy, which is not required to be reproduced, and a negative or reversed copy from which a number of direct copies can be taken. Such paper is covered on one side with a manifolding composition, and on the other with a simple copying composition, and is used between two sheets of paper with the manifolding side undermost.

The manifolding composition is made by mixing 5 ounces of printers' ink with 40 of spirits of turpentine, and then mixing it with a fused mixture of 40 ounces of tallow and 5 ounces of stearine. When the mass is homogeneous, 30 ounces of the finest powdered protoxide of iron, first mixed with 15 ounces of pyrogallic acid and 5 ounces of gallic acid, are stirred in till a perfect mixture is obtained. This mass will give at least 50 copies on damp paper in the ordinary way. The copying composition for the other side of the prepared paper consists of the following ingredients:

Printers' ink	5 ounces.
Spirits of turpentine	40 ounces.
Fused tallow	30 ounces.
Fused wax	3 ounces.
Fused rosin	2 ounces.
Soot	20 ounces.

It goes without saying that rollers or stones or other hard materials may be used for the purpose under consideration, as well as paper. The manifolding mass may be made blue with indigotin, red with magenta, or violet with methyl violet, adding 30 ounces of the chosen dye to the above quantities of pigment. If, however, they are used, the oxide of iron and gallic acids must be replaced by 20 ounces of carbonate of magnesia.—Oils, Colours and Drysalteries.

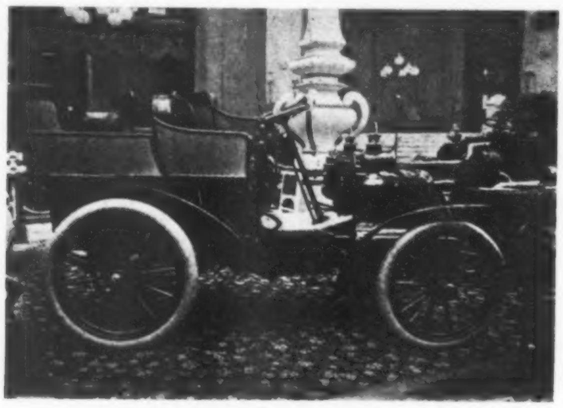
* See Prof. J. C. Bose on "Electric Touch and the Molecular Changes Produced in Matter by Electric Waves," The Electrician, vol. 44, p. 626, 1900.

† See Minchin on "The Action of Electromagnetic Radiation on Films Containing Metallic Powders," Proc. Phys. Soc., November 24, 1893; or The Electrician, vol. 22, p. 123.

‡ Prof. J. C. Bose has employed the terms positive and negative in the same sense.

PARIS AUTOMOBILE AND CYCLE SHOW.

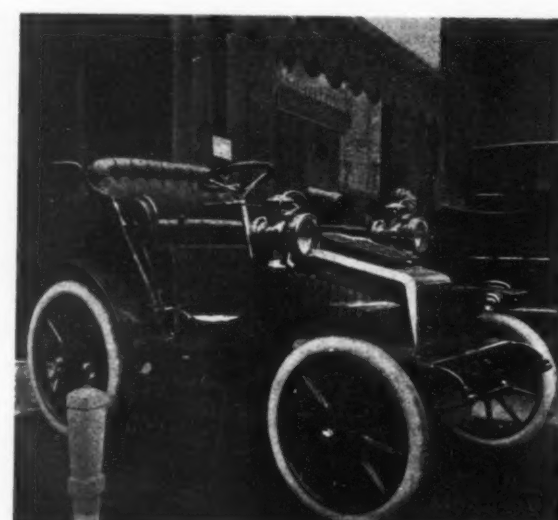
THE Third Annual Automobile and Cycle Show which has been lately held at Paris, proved a great success. This year it was installed in the Grand Palais, where it will no doubt be held hereafter. The exhibits of machines occupied four long lines extending the whole length of the vast building, while the galleries and remaining spaces were taken up with motors, trucks, and accessories of all kinds. Bicycles were also well represented. This exhibition, like the two which preceded it, was organized by the Automobile Club of France. The great number of exhibits show the advance which is being made in the automobile industry, and the novel types of machines and motors give evidence that the inventors are actively at work. The section devoted to motors showed interesting types working with gasoline, petroleum and alcohol. The question of the alcohol motor is occupying considerable attention at present, as it is desired to replace the imported petroleum by alcohol, which is a national product. It is hoped that the present high tax upon alcohol will be reduced, and the Minister of Commerce and Industry, after visiting the exhibition, promised to use his efforts in this direction. President Loubet showed a great interest in the different systems, and King Leopold II. of Belgium, an ardent chauffeur, made a number of visits. The retrospective exposition included, among others, the first electric automobile built by Jeantaud, 1895; the first steam vehicles of De Dion-Bouton, 1885-86; the Peugeot machine of the Paris-Brest race, 1891; the first Serpollet steam automobile, etc. Among the cycles may be mentioned that of M. Serrebrennikoff which made the trip from Russia to Paris; the bicycle with which Terront covered 600 miles; a velocipede in wrought iron made by a blacksmith of Vendome in 1869, and an old tricycle made entirely of wood. In the section devoted to aerostatics were to be seen several types of dirigible balloons, as well as the basket and accessories of the balloon "La Centaure," which made the voyage from Paris to Korosticheff, Russia, beating the record for distance.



PANHARD-LEVASSOR CARRIAGE.

Of the automobiles with gasoline motor, one of the most improved types is that shown by the Panhard & Levassor Company. This type of machine is built for 2, 3 or 4 places, and its motor will develop from 5 to 7 horse power. The motor, which is well balanced to lessen the vibration, has two cylinders, the ignition being made by burners of incandescent platinum. It has three speeds ahead and one reverse, these being controlled by a to-and-fro lever at the side of the conductor. The steering is carried out by a hand-wheel and endless screw mechanism, which acts upon the forward truck. The wheels are of wood with metal hubs, carrying pneumatics of 2.6 inches in front and 3.6 inches in the rear. The type of machine shown in the engraving weighs about 1,300 pounds, and has a nominal capacity of 7 horse power. The same company shows a number of other vehicles, all of the petroleum type, in which 2 or 4 cylinder motors are used. Many of these have platinum tube igniters, but in others electric igniters are used. The consumption of gasoline is claimed to be 0.15 gallon per horse power hour; the reservoirs are large enough to provide for a 180-mile run. The motors on all these machines are water-cooled, and the water circulation is so arranged that if the pump should fail to work by accident the water continues to flow by its own weight. The machines on exhibition by this firm include four 12-horse power automobile carriages, two omnibuses, and four heavy hauling wagons. One of the latter is of especially large dimensions, and is designed for coal hauling; it has a 12-horse power motor and weighs $2\frac{1}{2}$ tons, carrying a load of 3 tons.

A number of machines have been lately designed to work with alcohol, gasoline or a mixture of the two in variable proportions. One of the best of these systems is that of Gobron-Brillié, whose machine is shown in the engraving. The motor has two cylinders side by side, each cylinder carrying two pistons, with the explosion chamber in the center; the pistons are thus displaced in opposite directions. The upper pistons are connected together by an arched piece from which two rods pass down to the crank-shaft; the lower pistons are directly connected to this shaft. The motor carries a governor which acts upon the admission valve and regulates the supply of combustible according to the work to be produced. The speed of the motor may be varied by a handle in front of the conductor, which acts upon the governor and thus changes the motor speed from 300 to 1,300 revolutions per minute; the same handle acts upon the revolving contact for the spark igniter, so that the period of ignition is varied according to the speed.



GOBRON-BRILLIÉ CARRIAGE.

A machine of decidedly novel construction is that shown by the Compagnie Internationale des Transports Automobiles; it has been designed by M. Jenatzy. This machine carries an electric and a petroleum motor which work singly or in combination. The petroleum motor may be coupled to a small dynamo which charges a battery of accumulators. It is thus coupled when its total force is not needed to drive the machine, as in going down grades or on a level. In the contrary case, when greater force is needed the energy of the batteries is utilized and the dynamo is driven from these as a motor. M. Jenatzy, whose experience in constructing electric automobiles is well known, has brought this system to great perfection. A 6-horse power gasoline motor is used, and the electric motor is built for 14 horse power, the capacity of the batteries being 18.0 kilowatts. In case of a great resistance to be overcome, 20 horse power may be obtained by using both motors. The battery weighs 370 pounds and is placed in the rear of the vehicle. It carries a sufficient charge to allow a run of 20 miles without using the petroleum motor, in case this should fail to work. Although the combination of a petroleum and an electric motor may appear complicated, it has been realized in practice in a very simple manner. The same company showed a number of electric vehicles of improved type, such as a coupé, a 6-place road wagon, an omnibus and a delivery wagon, besides a voiturette which may be charged for a 90-mile run.

JENATZY ELECTRICAL AND PETROLEUM CARRIAGE.

BERLIN'S GREAT FIREMEN'S EXHIBITION.

THE growing importance of the office of the fire brigade in all countries, increased by the erection of tall buildings and the social needs of a more complicated civilization, will make the great firemen's exhibit at Berlin this summer of international interest.

In America particularly, in view of the fearful loss of life and property during the past year, despite the acknowledged pre-eminence of our fire-fighting armament, a keen interest will be felt in any new methods or apparatus exploited at this scientific exposition of the world's life-saving equipment.

The international exhibition for fire-preventing and fire-saving arrangements will be held from six to eight weeks, on the place of military exercises at Moabit, during the months of June and July. All European countries are expected to participate extensively in the exhibit.

Many firms have reserved a considerable space, and will erect pavilions. Stockholm alone is going to send two large steamboats for extinguishing fire—one being forwarded by the Stockholm fire brigade, the other by the Ludwigsberger Joint Stock Company. These, in view of the late tragedy at the Hoboken docks, will be of special interest to Americans.

Large building firms will erect fireproof theaters and working models of various buildings on the exhibition grounds.

A special interest will attach to the feature introduced in connection with the practical demonstrations of extinguishing fire; exhibitions of skill by expert firemen, etc.

Numerous governments headed by the Prussian government will award prizes of honor for the special merit of the exhibits, and give gold, silver, and bronze State medals for striking exhibits.

Because of the excellence of our fire brigades, it is particularly urged that American fire departments and manufacturers of firemen's supplies send exhibits to Berlin.

The North German Lloyd, the Hamburg-American Line, and many other large steamship companies have offered to take and bring back their exhibits free. The foreign exhibits will be delivered in Germany free of duty, which will only be charged in case the objects are bought.

Only objects which answer the purpose of the exposition will be accepted by the exposition authorities. That is, all articles exhibited must come under one of the following groups:

Group I.—Organization of the Fire Brigade.

(a) Clothing and equipments of fire brigades. (b) Horse equipment. (c) Dwellings for the firemen. (d) Apparatus—Extinguishers, escapes, apparatus for illuminating the way to and at the scene of fire. (e) Chemical fire-extinguishing means and machinery. (f) Water supply. (g) Firearms.

Group II.—Assistance in Case of Necessity and Danger.

(a) Ambulance corps. (b) Relieving persons and animals and transporting same in cases of accident. (c) Danger caused by water.

Group III.—Extra Professional Work.

(a) Cleaning streets. (b) Watering streets.

Group IV.—Fire-Protecting Means.

(a) Fire-proof building constructions. (b) Light-

ning conductors. (c) Heating apparatus. (d) Chimney sweeping. (e) Fire-Protecting Apparatus—For dwellings, schools, hotels, churches, hospitals, asylums, etc.; for factories; for storehouses; for transporting purposes, on land, on water; for mines; for electric plants. (f) Theaters. (g) Insurance against fire.

Group V.—Organization for the Benefit of Fire Brigades.

Group VI.—Subjects of Instruction, Art, and Literature.

All applications for space should be made to Mr. Emil Jacob, managing director, 41 Linden Strasse, Berlin, S. W. Cable address, "Feuerrettung," Berlin.

The form of application should state clearly the following points: Name of exhibitor, whether person or firm; city, street number, State and country of residence; area of space desired, i. e., length and breadth in meters (1 meter equals 39.37 inches); whether underground space or expanse of water is desired, and if so, how much; if a separate section or cabin is desired, how large in meters; if the exhibitor prefers to erect a special pavilion, a sketch of the same should be submitted, with dimensions stated in meters.

The application should further state if the apparatus to be exhibited will be set in operation; if so, by what kind of power; whether it is desired that tables or shelves shall be supplied by the exhibition authorities, whether the right of sale is reserved for exhibits, for what amount insurance against fire is desired, and finally, any special request that the intending exhibitor may wish to make in advance.

THE ANDERSON SHIP-RAILWAY.

So far back as 1883 Captain James Eads, one of America's most distinguished engineers, proposed the construction of a ship's railway across the isthmus which connects North and South America, and even went so far as to break ground at Tehuantepec. But the great engineer never lived to carry out his plan, and his railway for a decade or two slumbered peacefully until it has now been revived with certain improvements by a Brooklyn inventor, Mr. Axel B. Anderson.

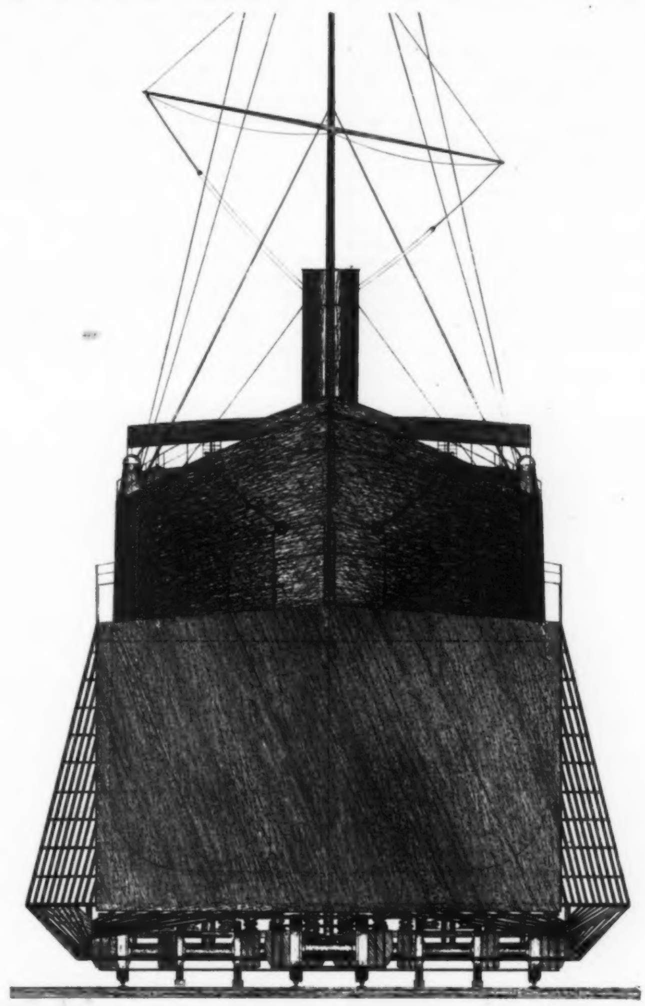
One of the features of Eads' railway, as engineers will doubtless remember, was a basin which constituted the real terminus of his road. To avoid extending the track out into the harbor, this narrow basin, 3,000 feet long, was to be excavated inland at right angles to the shore line. At the harbor end the basin was to be deep enough to place the railway 30 feet below the surface level of the water. From that point the track was to rise one foot in a hundred, so as to reach the surface level at the shore end of the basin. The outer end of each basin was to be provided with a caisson-gate or lock gates, so that the basin could be pumped dry when it was necessary to repair the track under water. In transferring a ship from the harbor to the upland track, a cradle or ship car was to be backed down to the upper end of the basin under water by means of a stationary engine. The ship was then to be floated in from the harbor so that her keel would rest over the cradle. Keel and bilges were then to be shored up very much as they are in drydocks. When entirely out of the water, the stationary engine was to be detached and two powerful locomotives were to haul the massive load.

Anderson's railway differs materially from that of Eads. The ship is not to be hauled on the tracks in a cradle, but is to be transported in water contained in a specially constructed wheeled-tank. The tracks for the tank are to be extended into the harbor or roadstead, so that the vessel may float into the tank. The end gates being then closed, the tank and vessel are hauled to dry land by a cable and stationary engine, and are then further driven by powerful locomotives. This, in brief, is Mr. Anderson's scheme.

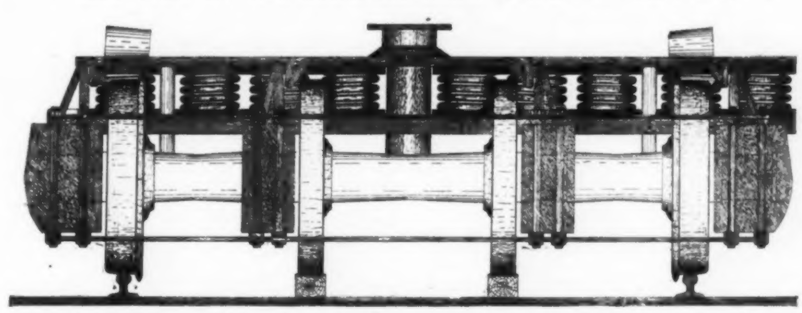
So far as the details of construction are concerned, there are important differences to be noted between the Anderson and Eads systems. Eads employed only T-rails, on which flanged wheels ran. Each wheel was to be surmounted by two strong steel springs to give sufficient elasticity to the load and lessen the liability to strain. Anderson intends to utilize two lines of main trucks, placed side by side on parallel rails, and end trucks running on the intermediate rails. Of the tracks which are to be employed, the outer are of the usual T pattern, and the inner of the strap-rail type, whereby a considerable saving in cost is secured. On the middle of the truck frames a bearing-plate is transversely supported; and along the bearing-plate a series of coiled supporting springs are placed side by side. On the springs a second plate is secured, connected by trusses with the first; and between the two plates a king-bolt is located. The tank is carried on the king-bolt and on bearing rollers at the extremities of the upper plate. The edges of the upper plate are embraced by a series of guide-standards, between which are guide-brackets, the whole construction of standards and brackets serving to control the upper plate against lengthwise and lateral play. To accommodate the slightest turning motion of the truck on the king-bolt, the rollers are slightly tapered. To support the tank-walls, a system of braces is employed, together with cantilever supports for the braces, and counter-braces for the cantilever supports abutting against the bottom of the tank and against thrust-bars which are suspended under the truck-frames between the wheels and others suspended behind the truck.

To provide an absolutely water-tight closure for the ends of the tank, novel caisson-gates are employed. Meeting edge plates have coincident grooves and intermediate abutting ribs. In one of the plates a key is pivoted, having flanges meshing with the grooves of the two plates when the gates are closed.

That both systems are operative cannot be doubted. We have the direct evidence of some of the most experienced shipbuilders—among them the former chief constructor of the British navy, E. J. Reed—to the effect that the transport of ships by rail is not only feasible, but that the plan is highly economical in comparison with a canal. Upon any road where it is possible to build a canal, it is equally possible to build and equip a substantial and durable ship-railway for one-half the cost of a canal. The time of construction Captain Eads estimated would be one-third or one-quarter of the time required for the building of a



END VIEW OF THE TANK, SHOWING SYSTEM OF BRACING.



END VIEW OF TANK-SUPPORTING TRUCK, SHOWING KING-BOLT AND ROLLERS.

THE ANDERSON SHIP RAILWAY.

canal. The speeds of transportation would undoubtedly be greater; at least one-fifth or one-fourth of the time would be required which is now spent in passing through a canal with many locks. Moreover, the capacity of the ship-railway can be easily increased to meet the demands of commerce without interruption to its business. It is also claimed that the railway can be located and successfully operated at localities where it is not practicable to construct a canal. An accurate estimate of the cost of a canal can rarely be given; for the execution of works under water, or liable to be submerged or interrupted by water prevents an accurate computation of probable cost. The work of a ship-railway is carried on wholly upon the surface of the ground; and for that reason alone the precise cost can be easily reckoned. Eads himself was willing to stake all that he possessed on the success of a ship's railway across the Isthmus of Panama; and had he lived he might possibly have carried out his plan. The new system which forms the subject of the present article shows that the idea has not perished, and that the system is constantly subjected to improvements which must sooner or later be embodied in an actual road.

THOMAS HENRY HUXLEY.

By Leslie Stephen.

There are some compensations, I am beginning to think, in the reflection that by 1860 I was qualified, by age at least, to enjoy the spectacle of intellectual swordplay. In that year took place the famous encounter at Oxford between Huxley and Samuel Wilberforce. It was one incident in a remarkable outburst of intellectual activity. The old controversy between scientific and ecclesiastical champions was passing into a new phase. Darwin's teaching had not only provided a fresh method, but suggested applications of scientific principles which widened and deepened the significance of the warfare. A "new reformation," as Huxley afterward called it, was beginning, and the intellectual issues to be decided were certainly not less important than those which had presented themselves to Erasmus and Luther. In the struggle which followed, Huxley took a leading part. He made original researches; he was the clearest expositor of the new doctrine to the exoteric world; he helped to organize the scientific teaching which might provide competent disciples or critics; and he showed most clearly and vigorously the bearing of his principles upon the most important topics of human thought. Whatever his success, the strongest antagonist could not deny to him the praise due to a strenuous and honorable combatant. The most careless Gallio looking on from the outer ring might be roused to applaud the intellectual gladiator who could hit out so straight from the shoulder and fairly knock accomplished prelates out of time. Many could admire "Darwin's bulldog," as he called himself, even if they felt some sympathy with the bull whom he pinned. Those who watched him from first to last will be glad to make a more intimate acquaintance with so grand a specimen of the fighting qualities upon which Englishmen are supposed to pride themselves. In Mr. Leonard Huxley's volumes they will find ample materials for filling out the more obvious and strongly marked outlines; and will end by adding to their respect for the sturdy intellectual warrior a cordial affection for a noble and warm-hearted human being.

The method which Mr. L. Huxley has adopted was clearly prescribed for him. He has appreciated the conditions of his task, and fulfilled them with excellent judgment. The biographer can never quite equal the autobiographer, but with a sufficient supply of letters he may approximate very closely to the same result. Huxley's letters are fortunately abundant, and amount to a singularly clear, though quite unconscious, self-revelation. The book, it is true, is of considerable dimensions; but in the first place, Huxley had so many interests that many topics require notice; and in the second place, the letters are almost uniformly excellent. The common complaint of the decay of letter-writing is partly answerable by the obvious consideration that most letters of our own time are still lying in their pigeon-holes. It is true, no doubt, that only an Edward FitzGerald or so here and there has the chance to write letters breathing the old-world charm of lettered ease and playful dallying with the humorous aspects of life or books. Huxley's letters were necessarily thrown out at high pressure to give pithy statements of his judgment of some practical matter, or friendly greetings for which he can just find time between the lecture room and the railway station. Their vivacity and constant felicity of phrase are the more remarkable. R. H. Hutton remarked quaintly upon the quantity of "bottled life" which Huxley could "infuse into the driest topic on which human beings ever contrived to prose." A more congenial phrase would perhaps be the amount of "potential energy" which was always stored in his brain. It is convertible at any moment into the activity of a steam-hammer, hitting the nail on the head in the neatest and most effective fashion. There are none of the flabby, tortuous blunderings round about a meaning, nor of the conventional platitudes of which so many letters are entirely composed; every word is alive. His mother, he tells us, was remarkable for rapidity of thought. "Things flash across me," she would say by way of apology. That peculiarity, says her son, "has been passed on to me in full strength;" and though it has "played him tricks," there is nothing with which he would less willingly part. The letters often scintillate with such flashes, the brighter for the strong sense of humor which is rarely far beneath the surface. They vary from the simply playful to the deeply earnest moods. He does not scorn even atrocious puns. But, of course, it is not the occasional condescension to "goaks," as he calls them, but the fine perception of the comic side of serious matters which gives a charm to his casual phrases. Sometimes it shows itself in a bit of friendly "chaff." When Matthew Arnold has appropriated—unconsciously, let us hope—an umbrella at the Athenæum, Huxley slyly exhorts him to consider what that excellent prelate, Arnold's favorite Bishop Wilson, would have advised in a case of covetousness. An excellent example of grave logic conveyed in an apologue is the letter in answer to Cardinal Manning's defense of indiscriminate charity. Huxley had told an Irish carman to drive fast, and the man set off at a hand-gallop. "Do you know where you are going?" cried Huxley. "No, yer honner; but, anny way I'm driving fast!" A phrase in a letter to Mr. Clifford dashes out a quaint comment upon human nature. "Men, my dear, are very queer animals—a mixture of horse nervousness, ass stubbornness, and camel malice, with an angel bobbing about unexpectedly like the apple in the posset; and when they can do exactly as they please, are very hard to drive." This, says Mr. Leonard Huxley, sounds like a bit of his conversation; and in a very interesting description Sir Spencer Walpole remarks on that manifestation of his powers. Huxley, he says, "could always put his finger on the wrong word and always instinctively choose the right one." In private talk, lecturing, and public speaking, he was conspicuous in the humorous felicity which equally marks his admirable literary style.

"Science and Literature," said Huxley, "are not two things, but two sides of one thing." An aphorism in an after-dinner speech must not be too literally construed, but the phrase indicates the quality which makes Huxley's writings as refreshing to the literary as to the scientific critic. "Exposition," he observes, "is not Darwin's forte. But there is a marvelous dumb sagacity about him like that of a sort of miraculous dog, and he gets to the truth by ways as dark as those of the Heathen Chinee." The final cause of Huxley might seem—though the theory is a little out of place—to have been the provision of an articulate utterance for Darwin's implicit logic. He points an old moral for young literary gentlemen in want of a style. He does not believe in molding one's style by any other process than that of "striving after the expression of clear and definite conceptions." First, indeed, he adds, you have to catch your clear conceptions. I will not presume to say that for writers of a different category—Stevenson, for example—a different method may not be the right one. But most of us may heartily subscribe to Huxley's theory. The best way to be happy, as moralists tell us, is not to make the acquisition of happiness a conscious aim. To acquire a good style, you should never think of style at all. It will be the spontaneous outcome of adequate expression of clear thought. Some writers, Huxley admits, might have learnt dignity from a study of Hobbes, and concision from Swift, and simplicity from Defoe and Goldsmith. The names are significant of his taste; but he learnt by adopting the methods of his predecessors, not by imitating them as models. The labor which he bestowed upon his work is the more remarkable, considering his quickness in seizing the right word in his hastiest letters. He speaks of writing essays half a dozen times before getting them into the right shape. He had the passion, unfortunately rare in Englishmen, for thorough logical symmetry. His "flashes" must be finished and concentrated. The happy phrase has to be fixed in the general framework. Arguments are terribly slippery things; one is always finding oneself shunted into some slightly diverging track of thought; and brilliant remarks are most dangerous seducers. They illustrate something, but then it is not quite the right thing. Huxley gets his Pegasus into the strictest subordination; but one can understand that he had to suppress a good many swervings to right and left, and only found the lucid order after experimental wanderings into the wrong paths. The result is the familiar one. What is easy to read has not, therefore, as the hasty reader infers, been easy to write. An "unfriendly" but surely rather simple-minded critic declared that the interest of Huxley's lectures was due not to the lecturer, but to the simplicity of the theory expounded. That is the effect which Swift produces in the "Drapier's Letters." He seems to be simply stating obvious facts. Huxley's best essays deserve to be put on a level with the finest examples of Swift or other great literary athletes; and any one who imagines the feat to be easy can try the experiment.

Professor Ray Lankester, in describing this quality of Huxley's essays, points out also how this implies a revelation of the man. When Swift's tracts purport to give an unvarnished statement of plain facts and figures, we are all the more sensible of the fierce indignation boiling just below the surface. Huxley's resolution to be strictly logical, and to be clear before anything, only forces him to exert his powers of vivifying the subject by happy illustration or humorous sidelights, or sometimes by outbursts of hearty pugnacity, and now and then by the eloquent passages, the more effective because under strict control, which reveal his profound sense of the vast importance of the questions at issue. He had one disadvantage as compared with Swift. If Swift wanted a fact, he had not many scruples about inventing it, whereas Huxley's most prominent intellectual quality was his fidelity to fact, or to what he was firmly convinced to be fact. This brings me to some characteristics strikingly revealed in these volumes. Huxley claims that he had always been animated by a love of truth combined with some youthful ambition. The claim, I think, is indisputable. Yet a love of truth must be considered, if I may say so, as rather a regulative than a substantive virtue. Abstract truth is a rather shadowy divinity, though a most essential guide in pursuing any great inquiry. Love of it presupposes an interest in philosophy or science or history, and then prescribes the right spirit of research. Huxley was not one of the rare men to whom abstract speculation is a sufficient delight in itself. He was most emphatically a human being, with strong affections and a keen interest in the human life around him. He had to live as well as to think, and to reconcile his intellectual ambition with hard necessities. The pith of his early story was already known in part from his autobiographical fragment. Further details make the picture more impressive. For a time he had to thrive under conditions which were only not blighting because his courage made them bracing. The school at which he got his brief training was a "pandemonium." He wished to be an engineer, but was forced to become a medical student against the grain. He found, however, a sufficient arena for the exercise of his awakening faculties. Physiology, the "engineering of living machines," attracted him, though he cared little for other parts of the necessary studies. From Carlyle he learnt a hatred of "shams," or perhaps rather learnt to formulate an innate antipathy to that commodity. Carlyle, too, set him upon the study of German, afterward invaluable, and suggested some early incursions into the field of metaphysics. A fortunate accident afterward forced him to spend four years in the "Rattlesnake," where his personal accommodation, as he testifies, was not much better than Jonah's; where he had to pass months without seeing civilized beings, except the companions who were as indifferent as the Australian aborigines to scientific pursuits. He made friends of them not the less, and declares that the life on board ship, under sharp discipline, with a "soft plank" to sleep upon, and weevily biscuit for breakfast, was well worth living. It taught him to work for the sake of work, even if he and his work were to go to the bottom of the sea. He returned to England to find that some of his work had been appreciated, and to gain some warm friends. Still, it looked as though a "life of science" would mean a "life of poverty," but a "life of nothing," and the art of living upon nothing, especially with a family, had not yet been discovered. Yet the desirability of living somehow had been enforced by the greatest blessing of his life—the engagement in Australia to the lady to whom he writes this account. He still feels, however, and he counts with complete confidence upon her sharing his feeling, that he is bound, for his own credit, for the sake of his friends, and of science itself, to keep his hand to the plow. How his persistence was rewarded, how he gradually emerged, secured in spite of vexatious delays a sufficient support to justify the long-delayed marriage and to carry on the task which he had accepted, may be read in these volumes. In later years the duties of a husband and a father forced him to give up the line of research to which he had aspired. But he was not less working in the great cause of propagating what he believed to be the truth; fighting its enemies and organizing its adherents. He was "driven into his career," as he says in his autobiography, rather than led into it of his own free will. Yet the dominant purpose was equally manifest, though stress of circumstances and conflict of duties might force him to set his sails to devious winds. If he could not select the career which ambition of purely scientific fame might have dictated, he would accept none which involved the slightest compromise with falsehood; and probably took, in fact, the part most suitable to his peculiar cast of intellect. When Huxley took up the gauntlet for Darwinism, and first became widely known to the extra-scientific world, his aspirations might be described with curious accuracy in the words of the poet whom he held to have appreciated most clearly the tendencies of modern scientific thought. The first speaker in Tennyson's "Two Voices" recalls the early phase when he listened as "the distant battle flashed and rung"; sang his "joyful pæan," and burnished his weapons,

> "Waiting to strive a happy strife,
> To war with falsehood to the knife,
> And not to lose the good of life."

He was to "carve out free space for every human doubt;" to search through

> "The springs of life, the depths of awe,
> And reach the law within the law;"

and finally to die,

> "Not void of righteous self-applause
> Nor in a merely selfish cause,"

but

> "Having sown some generous seed,
> Fruitful of further thought and deed."

Huxley, indeed, never gave in to the despondency which led the second voice to recommend suicide; nor did he precisely accept the consolations which the first voice ultimately accepts in the sight of a lady and gentleman going to church with their daughter. He plunged into the war, and found satisfaction in the simple joy of successful combat. When, thirty years after the round with Bishop Wilberforce, he again attended another meeting at Oxford, and, veiling criticism in eulogy, welcomed Lord Salisbury's address as an involuntary testimony to the victory of evolutionism, he could look back with a feeling of triumph. A change of thought of unprecedented magnitude had been admitted even by the enemy. Some, indeed, held that the doctrine once scornfully rejected was to become the corner-stone of a new edifice of faith. In any case, if the chief value of a new speculation lies even more in the fermentation which it sets up than in the results which it finally establishes, no one disputes the enormous importance of the Darwinian theories. I have sufficient reason for not saying a word upon the part which they have played in the physical sciences. Their influence, however, upon other problems has been one of their most remarkable peculiarities. Huxley insisted upon such applications; and as many of his ablest writings appeared in the pages of this Review, I will venture—not, of course, to examine his arguments, but to note the characteristic position which they implied. Huxley remarks somewhere that he had learned to be a judge of the art of controversy, to appreciate the skill displayed in the contest abstractedly from the merit of the positions defended. That may seem to imply a delight in battle for its own sake. The athlete rejoices in putting forth his power, and I cannot see my way to deny that Huxley was pugnacious. In fact, I cordially admire and envy a quality which indicates both courage and the spirit of fair play. Huxley himself, indeed, was given to make frequent disavowals; his fights—they were many—he admits—were forced upon him; except, indeed, in two (or "by'r lady," one is tempted to interject, some "three-score") instances. What is the "forcing" in question—who really began the fight—is a difficult question to answer in most quarrels. If a man has hazel eyes, according to high authority, another man who cracks nuts is obviously taking the aggressive. Huxley, while warning a younger man against quarrels, anticipates the obvious *tu quoque*, and explains that in his own case warfare had been a simple duty. The position is explained in one of his prefaces. He never, he declares, "went out of his way" to attack

the Bible. The dominant ecclesiasticism thrust the book in *his* way, and marked "No thoroughfare" where he claimed an indefeasible right of passage. He therefore brushed the barrier aside, and expressed his contempt for it with a slight excess of vivacity. Other men—his leader Darwin, for example—were content quietly to disregard the warning; to leave the destruction to be done by the professional critics, or perhaps by the authorities themselves, who would presently explain that "No thoroughfare" really means "Please walk in." Huxley was not a man to suffer fools gladly, or to lay down a principle without admitting and emphasizing its unpopular consequences. That might possibly show a want of prudence; but the alternative course may be imputed, with at least equal plausibility, to want of sincerity. Once, as Huxley admits, he showed "needless savagery" in his early youth, and no doubt could use pretty strong language. His adversaries had set the example. The special constable in Leech's drawing says to the rough: "If I kill you, it is all right; but if you kill me, by Jove, it's murder." If I call you a child of the devil, and sentence you to hell fire, says the orthodox, it shows my holy zeal. If you call me a bigot or a fool, it is flat blasphemy. Huxley might plead that he was not bound to use the gloves when his opponent struck with naked fists. No one has a right to object to plain speaking; and the cases in which Huxley's plain speaking is edged with scorn are always cases in which he is charging his antagonists (as I, at least, think on very strong grounds) with want of candor. Refusal to withdraw a disproved personal allegation, or an attempt to evade the issue under a cloud of irrelevant verbiage, roused his rightful indignation. "Thou shalt not multiply words in speaking" was, he observes, an old Egyptian commandment, specially congenial to him, and most provokingly neglected by a conspicuous antagonist. A plain speaker may be pardoned for resenting attempts to evade plain issues under clouds of verbiage. The pugnacity remained to the end. A challenge to a controversy acted as a tonic, and "set his liver right at once." But he cannot fairly be accused of a wanton love of battle. Forced by health and circumstances to refrain from scientific research, Huxley had taken up with all available energy the old problems of religious belief. He read the latest authorities upon Biblical criticism with singular freshness of interest and keenness of judgment. He could not, of course, become an expert in such matters, or qualified to take an authoritative part in the controversies of specialists. But he was fully competent to insist upon one essential point, and even bound to speak, if it be a duty to propagate what one believes to be a truth of vast importance. His articles converge upon a principle which, if fairly appreciated, explains and justifies his method. In the long war between faith and science, one favorite eirenicon has been a proposed division of provinces. Reason and authority may each be supreme in its own sphere. Huxley argues that this separation is radically untenable. An historical religion must rest upon evidence of fact; and the validity of evidence of fact is essentially a scientific problem. When Protestants appealed from the Church to the Bible, they pledged themselves unconsciously to defending the Bible in the court of reason, and the old evidence writers frankly accepted the position. They tried to prove fact by evidence. Whether Noah's flood did or did not really happen is a question both for the geologist and for the historian. One relies upon what is called "direct," and the other upon "circumstantial" evidence, but the canons of proof are identical, and the fact to be established is the same. If it cannot be established, the inferences, whether religious or scientific, must go with it. Some readers complained that Huxley was slaying the slain, and that it was as needless to disprove the legend of Noah as the story of Jack the Giant-Killer. The complaint was an incidental and perhaps not unnatural result of his method. His strategical instinct led him to seize the weakest point in the line of defense. He had occupied the key to the position; and thought a guerrilla war may still be carried on by people who don't know when they are beaten, their final defeat can be only a question of time. But that was just the point which hasty readers might fail to perceive. The disproof of the flood implied, as he held, the disintegration of the whole foundations of orthodox belief in the Hebrew legends. The argument about the Gadarene swine, as he admitted, seemed to some people to be superfluous—though one gallant antagonist still held to the truth of the legend. When, indeed, it branched out into the further question whether, if the miracle had taken place, it would have involved a disregard of the owner's legal rights, he apologized for his pugnacity by the incidental bearing of his argument upon Mr. Gladstone's authority. But, as he fully explained, especially in his prefaces to the collected essays, the force of the argument is in the necessary implication. Accept the story, and you must admit the whole system of demonology, which is flatly contradicted by all scientific evidence. Admit its absurdity, and you destroy the authority of the witnesses to the cardinal points of the miraculous story—the supernatural birth and the resurrection upon which the Christian dogmatic system is founded. The witnesses may record honestly the beliefs of their time, but they do not tell us upon what evidence those beliefs rested; and their whole intellectual attitude prepared them to accept statements which now seem monstrous. The early Christians were still Jews, in theology as well as in demonology. It tickled his sense of humor to call in Newman as an ally. There is no better evidence, as Newman had urged, for the early than for the later miracles—that is to say, none worth mentioning. Newman's doctrine of development admits equally that the Christian dogma was not taught by the primitive Christians; and the conclusion naturally follows that the development was perfectly intelligible, and requires no supernatural interference. When the admission of scientific canons of evidence has compelled the abandonment of certain positions, the application of the same canons excludes the whole supernatural element of belief. Huxley, in short, presses a dilemma. You rely upon evidence. Rejecting altogether the *a priori* argument against miracles, he admits that sufficient evidence might prove any facts whatever, however strange. But all evidence must be tested by appropriate canons of proof. If the proof involves the acceptance of an obsolete demonology, you must not accept it for theological and reject it for medical purposes. Frankly to accept the superstition implied in the Gadarene story is the only position logically comparable with orthodoxy, but it involves a declaration of war against science in general. Reject the superstition, and you have then destroyed the value of the evidence upon which you profess to rely. Men, whose ability is as unquestionable as their sincerity, have of course implicitly denied the force of this challenge. Theologians have assimilated evolution, even in the Darwinian form, and accepted the results of a criticism once supposed to be destructive without admitting the destructiveness. The final result remains to be seen, and I will only suggest that Huxley's challenge requires a plain answer. To accept the criteria of historical inquiry essentially implied in your methods is to abandon the results of the old methods. To make the narrative thoroughly historical, must you not in consistency get rid of the supernatural? If you admit that the evidence is at second-hand, or given by credulous, superstitious, and uncritical writers, and is therefore worthless for scientific, can it be sufficient for religious purposes?

I merely wish to emphasize Huxley's position. He was not simply attacking mere outworks—excrescences which might be removed without damage to the structure; but arguing that to abandon them was to admit the invalidity of the whole system of orthodoxy. He was surely not trespassing beyond his province. The truth of religious belief cannot be a question reserved for critical experts. If a man of science, or even of simple common sense, is required to believe, he is entitled to inquire into the method by which the belief is supported. The evidence adduced must be such as on the face of it to satisfy the general criterions of proof. Huxley's argument is that the testimony is by its nature not admissible for its purpose, and that to accept it would imply the abandonment of the most established scientific doctrines. He was therefore quite justified in asserting that he had not gone out of his way. A man of science may, of course, be content to write about electricity and leave Biblical criticism to others. But, in the first place, Huxley's scientific researches were on the very border where science and theology meet, and led directly to some fundamental problems. And, in the second place, he had been profoundly interested in the practical applications which affect a man of deep affections and compelled both by character and circumstances to take life in deadly earnest. He had to pass through a sharp struggle and, as a brave man should, resolved to come to a clear understanding with himself as to the aims and conduct of life. A very remarkable letter to Charles Kingsley exactly illustrates the point. It shows, as his son remarks, the genuine man more clearly perhaps than any of his writings. Huxley and his wife had suffered under the almost crushing calamity of the sudden death of their first child, who had lived just long enough to become the apple of his father's eye. Kingsley, one of the most generous of men, though not one of the sharpest dialecticians, had written a cordial letter of sympathy and taken occasion to set forth some of the beliefs in which he would himself have found consolation. Huxley replies at length, with a frankness creditable to both. He has no *a priori* objection to the belief in immortality, except that it is totally without evidence. The further assertion that an unproved and unprovable doctrine is necessary to morality is altogether repugnant to him. The "most sacred act of a man's life" is the assertion of a belief in truth. Men may call him what other hard names they please, but they shall not call him "liar." The blow which had stirred all his convictions to their foundation had not shaken that belief. "If wife and child and name and fame were all lost to me one after the other, still I would not lie." He speaks, as he says, more openly and distinctly than he ever has to any human being except his wife. He has been standing by the coffin of his little son, and his force and solemnity show how deeply he is moved. The clearness and moral fire unite, as Mr. Huxley says, "in a veritable passion for truth." The summary of his position reveals the secret of his life and character. He had learned, he says, from Sartor Resartus that "a deep sense of religion was compatible with the entire absence of theology." Science had given him a resting-place independent of authority; and finally love had "opened up to him a view of the sanctity of human nature, and impressed him with a deep sense of responsibility." Any one who has passed through a similar trial can read one secret. "Consolation" offered by well-meaning friends deserves the gratitude which Huxley expresses to Kingsley. Yet the suggested comfort becomes an unintentional but a most bitter mockery if it be not solid as well as sincere. Proof that your sorrow is founded in error might be infinitely welcome. But in proportion to the satisfaction which would be given by a real proof is the pang of recognizing that it is a baseless assertion. It really declares, not that the belief is true, but that, if true, it would be pleasant. You are invited not to face your trouble, but to seek refuge in dreams. When such beliefs are defended, not in some cruel crisis, but as an encouragement in the great battle of life, they encourage systematic self-deception, and, when laid down as the ultimate ground of morality, they become not only empty but directly corrupting. Huxley's hatred of shams meant the refusal of a brave man to shut his eyes, and scorn for those who deliberately provided convenient bandages for the purpose. His strongest conviction, as he says in the autobiography, was that the one road to the alleviation of human suffering was veracity of thought and action, and "the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off."

The religion reached from such a starting-point is, of course, not such as appears to most people to be a religion at all. Yet it is a system of belief which has been enough for the greatest minds. "The only religion which appeals to me," he writes to Romanes, "is prophetic Judaism. Add to it something from the best Stoics and something from Spinoza and something from Goethe, and there is a religion for men." The Stoics, as he says elsewhere, "had cast off all illusions" and found in the progress toward virtue a sufficient end of existence. He valued even the orthodox dogma for the same reason. He was for Butler against the deists. Theologians had recognized realities—though in strange forms. Predestination, original sin, the "primacy of Satan in this world," were a good deal nearer the truth than the comfortable optimism which culminates in Pope's lines, "Whatever is, is right." Adherence to fact is the base of his philosophy. Agnosticism, according to him, means simply that you are not to accept as an established fact anything not fairly proved. It led to conclusions which appeared paradoxical to some readers. He used, as he says, "materialistic terminology," and repudiated materialistic philosophy. Physiology proves that, in fact, the brain is a mechanism and the organized body an automaton. Psychology shows equally that every phenomenon must, as a fact, be an affection of the mind. You must neither pervert nor go beyond fact. Materialism and Spiritualism are "opposite poles of the same absurdity"—the absurdity of assuming that we know anything about either spirit or matter. The apparent contradiction is the result of trying to transcend the necessary limits of thought. The striking essay upon "Evolution and Ethics" brings out another contrast. Evolution, he maintains, "accounts for morality," but the principle of evolution is not "the ethical principle." The ethical progress "of society depends not on imitating the cosmic process, still less in running away from it, but in combating it." The microcosm will have a long fight against the macrocosm, and "may count upon a tenacious and powerful enemy as long as the world lasts." These are the facts, and, while giving hope for the future, he orders us not to indulge in any millennial anticipations. We see why he appreciates the truth implied in the "primacy of the Devil."

I cannot inquire, of course, into the validity or consistency of these doctrines. But they illustrate the concluding formula of Huxley's creed. Love, he says, has explained to him the meaning of "sanctity" and "responsibility." The phrase, perhaps, might suggest a vein of thought not very congenial to Huxley's turn of mind. He was fully alive to certain misapplications of his text. "The world," he observes to Tyndall, "is neither wise nor just, but it makes up for all its folly and injustice by being damnably sentimental." The truer Tyndall's portrait of the world, therefore, the louder will be the outcry. Nobody could be more heartily opposed to "sentimentalism." If I had space, I might illustrate the obvious remark by the admirable common sense of his remarks upon political, educational, and social questions. He is far too sensible of the gravity of the existing evils not to part company with the enthusiasts who believe in hasty panaceas and manufacture them out of fine phrases. To convert an amiable sentiment into a maxim of universal validity, to override facts and refuse to listen to experience, to "drive fast," like his Irish carman, without asking where you are going, was, of course, contrary to all his convictions. But the deep and generous interest in all well-directed efforts at alleviation is equally conspicuous. He was not an indiscriminate philanthropist; he hated a rogue and did not love a fool; and he held that both genera were pretty numerous. But he was a most heartily loyal citizen, doing manfully the duties which came in his way and declining no fair demand upon his co-operation. And the secret is given in the phrase about love. His son has given, for obvious and sufficient reasons, little direct account of Huxley's domestic life, and the allusions to his private happiness suggest more than could find overt expression. Yet the book cannot be read without a pervading impression of the life which lay behind his manifold scientific and official activities. Like Wordsworth's "happy warrior," he was one who, though endued with a "faculty for storm and turbulence,"

> Was yet a soul whose master-bias leans
> To homefelt pleasures and to gentler scenes.

It was not merely that he was surrounded by a sympathy which strengthened him in his work and soothed the irritations of intellectual warfare; but that such a home makes life beautiful, gives a meaning to vague maxims of conduct, and deepens the sense of "responsibility." The happy warrior is "more brave for this, that he has much to love." The intensely affectionate interest, combined with a high sense of duty, spreads beyond the little circle in which it is primarily manifested. That Huxley had his sorrows, felt with unusual keenness, is incidentally revealed; but we can see more clearly than it would be right to express openly, even were expression possible, what was the source of the happiness and continued vigor which threw brightness over his career. I have been in company with eminent men whose brilliant talk, revealing wide knowledge and great powers of mind, has charmed their hearers and justified cordial admiration. The special characteristic of the evenings spent at Huxley's was that such admiration was almost lost in the pleasure of belonging for the hour to a circle made perfectly harmonious by the unobtrusive but obvious affection which bound its members to the central figure. His home was a focus of the best affections not less than of intellectual light.

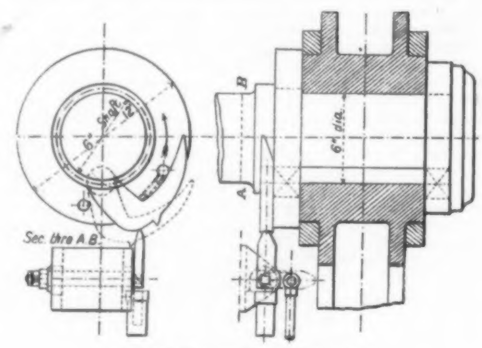
One result is more open to observation. Men of science have their weaknesses and temptations. They are not always more free than their literary brethren from petty jealousies and unworthy lust for notoriety. Huxley's life shows an admirable superiority to such weaknesses. His battles, numerous as they were, never led to the petty squabbles which disfigure some scientific lives. Nobody was ever a more loyal friend. It is pleasant to read of the group which gathered

round Darwin, himself the most attractive of human beings. Huxley seems to have retained every friend whom he ever made; and one understands their mutual regard. His life proves what was already illustrated by Darwin's, how honorable and dignified may be a career honestly devoted to the propagation of truth, little as it brings in the way of external rewards. The quaintly named X Club, which for twenty years lost none of its members, consisted of Huxley himself, George Busk, Sir E. Frankland, T. A. Hirst, Sir Joseph Hooker, Sir John Lubbock, Mr Herbert Spencer, W. Spottiswoode, and John Tyndall. It is enough to mention the names of men with such high and varied acquirements, to suggest a pleasant reflection. There is, I fancy, no period of our history at which an equally accomplished group of scientific luminaries could have been brought together or preserved such friendly relations. Huxley had the best of comrades, and well deserved to have them. He would speak of the pleasure given in his early controversies, by the consciousness that he was serving under so well-loved a leader as Darwin. Between all the members of his society there seems to have been the cordial comradeship of loyal fellow-soldiers in some great enterprise. There is a kind of short history, as I fancy, given in the portraits in these volumes. He had been, as his mother assured him, a very pretty child; and the assurance convinced him that this was one of the facts which are strongly in need of sufficient evidence. The earliest portraits, in fact, do not suggest good looks, though they show a quaint, humorous face with a mouth clearly suggestive of the bulldog. But he improves as he grows older, and in the final portrait we have the expression remembered by all who saw him; where the old combativeness is represented by the straightforward glance of the timeworn warrior, but softened by a pathetic glow of the tender and affectionate nature which blends so happily with the sterner expression, and shows the truly lovable emerging from, and naturally blending with, the masculine nature.—The Nineteenth Century. Reprinted by permission of the Leonard Scott Publication Co.

AN IMPROVED BRICK AND TILE PRESS.

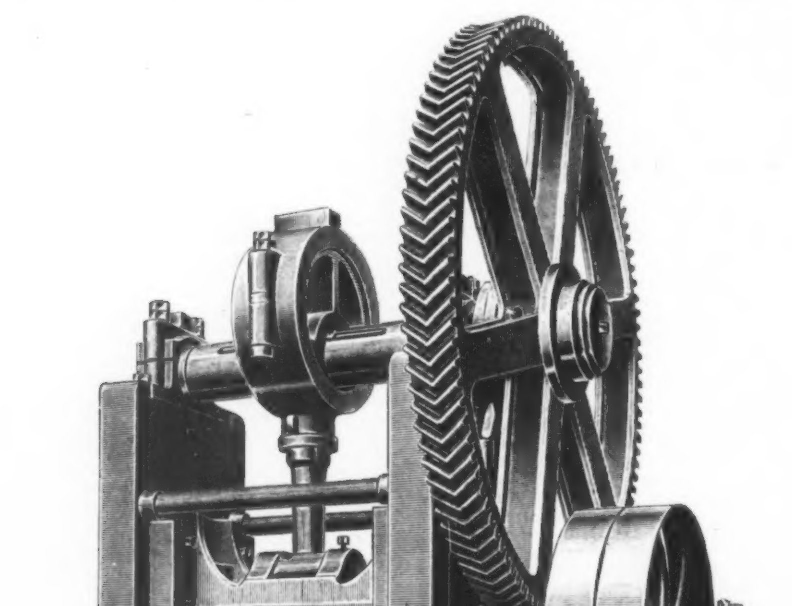
THE accompanying illustration represents an improved steam-power brick, tile, and quarry press, made by Bradley & Craven, Limited, of Wakefield. It has been designed to deal with articles above the normal size of a brick or tile, and will take such goods up to nearly 2 feet square. The crosshead works in large adjustable V slides, and has ample surface for keeping it true with the die. The gearing, as will be seen, is of the double helical form, which makes the running noiseless. The eccentric and stamper rod are of best cast steel, while the eccentric or pressing shaft is of forged steel. The pressing shaft is provided with a roller or revolving key which enables the press to stop at each revolution—an important feature when doing certain classes of work, notably, ornamental goods, for it gives whatever time is required for the placing in of the articles to be pressed and the removal of them from the machine. The construction of the machine is as follows:

The outer end of the pressing shaft has a key groove cut in it of concave shape, and the roller or revolving key is machined concentrically with it where working



AUTOMATIC KNOCK OUT GEAR

on the boss of the driving wheel, thus allowing it to rotate on the shaft while running idle. The key is fixed at each side of the wheel in collars secured to the shaft, and in these it is allowed to turn or partially revolve to present an eccentric form when driving. It has a forged tail at the end nearest the frame of the press, and this rests on a pointer or stop when the machine is doing no work. The small cut will serve to make this description of the roller key more explicit. To put the machine in operation a treadle lever is depressed, moving the pointer sideways, and by means of a spring attached to the tail of the key, it partially turns the latter round and presents a driving edge to the groove in the wheel, and the shaft thus makes a rotation and presses the article in the die. The pointer being allowed to come back to its original position, the tail of the key strikes it, turning it back in the groove, and the wheel again runs idle on the shaft. The pointer is fixed in such a position that the eccentric is brought to a standstill at the top of the stroke, and the shaft cannot make another revolution until the treadle is again depressed and the driving edge of the key brought into contact with the groove in the wheel.—The Engineer.



BRICK AND TILE PRESS.

CALCIUM CARBIDE AND ACETYLENE IN EUROPE.*

THE calcium carbide industry is quite recent in Europe, and yet there are about 76 factories at work on this product. Of this number the French establishments are the most numerous and important, and their plant is such as to soon double the production.

The following is the distribution by countries: France, 21; Switzerland, 11; Austria, 8; Germany, 8; Italy, 7; England, 4; Sweden, 4; Russia, 2; Spain, 2; Belgium, 1. In the United States there are 6, and in Canada 2.

The French factories have a force of 50,300 horse power, of which they now utilize 20,500, as follows: Bellegarde, 1,700; Chaparcillan, 800; Chede, 2,000; La Bathie, 2,750; Briançon, 3,000; Epierre, 2,600; St. Béron, 2,000; Sechilienne, 1,200; Serres, 600; Giffre, 880; Froges, 275; Le Praz, 1,450; Campagna, 600; Marsac, 350; Salies, 300. We have not the figures for the factories of Arudy and of Castelet.

At Niagara Falls, the American company are using 10,000 horse power, only two-fifths of the force at its disposal. When this factory is complete, it will be the most colossal industrial establishment in the world. With 25,000 horse power and 100 furnaces, it can turn out 100 tons of carbide per day.

It is difficult to estimate the production of the European factories. The production is not regular. Some factories are idle in summer from failure of water; the production of others is at times restricted from the general inadequacy of the source of supply.

The financial results have not always been satisfactory, and some factories have been obliged to shut down.

The manufacturers have had to study the needs of consumption and their relations with patentees.

In many cases the capital has been increased; in others useless patents have been paid for dearly. However, the Neuhausen factory, in Germany, distributed in 1899 a dividend of 12 per cent.

After trying very complicated furnaces, there is now a return to the simpler forms. At Lanymthal, in Switzerland, the furnaces consist of simple firebrick chambers, in which iron boxes, containing the mixture of lime and coke, are introduced. At Bellegarde, the Bertolus furnace is employed; at Saint-Marcel, the Memmo furnace. In the other factories named, threefold currents are used. A recent patent for continuous production is under trial, and if satisfactory, the intermittent production will be replaced with uninterrupted processes.

The Héroult furnace is probably the one most generally employed in Europe.

The production of carbide is unequal, and estimated as much below the amount that ought to be produced. The cost varies materially according to the freight and other expenses with which it may be loaded.

Thus, in the Pyrenees, at Lourdes, the Swiss carbide is sold at 580 francs per ton, but a factory in the vicinity has lowered the price to 290 francs. In Switzerland, the carbide is sold at 340 francs, but the same article at Paris at 460 francs. At Niagara, the price has been 190 francs, lowered to 145 francs.

At the Méran factory, the one provided with the most approved appliances, the cost is thus given: Electric force, 45.80 francs; lime, 18.80; coke, 26.00; electrodes, 16.50; crushers, etc., 5.00; manual labor, 18.50; packing, 5.00; interest and depreciation, 24.85; general expenses, 20.00; repairs, 7.50; transportation, 3.00. Total, 190.95 francs.

The patents connected with the production have often been suspended. In Germany, the Bullier patents have been adjudged invalid, and the machine is entirely free.

In England, the use of the Wilson patents has been stopped, and they cannot, it is believed, be enforced by the holders.

As to generators, the patent offices continue to be besieged with applications. In England alone, more than 600 patents have been issued on generators and acetylene lamps, and it is stated that scarcely one out of a hundred has any practical value.

The great majority of these patents is based on processes long known and studied by savants who have been concerned in the production of the gases. The only modification consists in the automatic apparatus stopping ingress of water, apparatus which in practice often fails to work at the critical moment.

The financial position of the industry does not appear well established. In many cases the only benefits have been derived by those who have floated the stock of the companies. In England, half the stock is controlled by those to whom it has been hypothecated. In this country, in 1899, 15 companies, representing a capital of more than ten millions, were organized. In the same year 3 companies went into liquidation. In Germany, the result has been the same. In general, the acetylene companies can derive a profit, provided the stock has not been watered; but, with all care in the management, the return has never exceeded 6 per cent.

The purification of acetylene gas has been the object of much study and many experiments.

This purification has been recognized as absolutely necessary for all gas designed for public or domestic lighting.

We will describe the different processes briefly:

Lime water removes all impurities, except hydrogen phosphide, the most dangerous of all.

The Lunge purifying mixture may give rise to nitrogen chlorides, a process also condemned.

The solution of cupric chloride (the Franks process) and that of chromic acid (Ulmann process) afford guarantees. These substances may be mixed with pulverized quartz; 5.5 grammes of chromic acid are deemed sufficient to purify 1 cubic millimeter of acetylene, but it is evident that this proportion must be

* Translated from the Revue Générale Française et Etrangère.

varied with the proportion of impurities. M. Caro recommends submitting the purified gas to the action of paraffin to remove the last traces of impurity, due to the chemical agents employed.

Each patentee champions his invention. Thus Lunge claims that the only danger from the use of his process proceeds from elevation of the temperature of the gas on coming from the generator. But the fire at the Buda-Pesth Exposition and the explosion of a factory have caused it to be abandoned. It is true that these accidents are attributed to the use of sawdust as an absorbent, and it is claimed that pulverized flint, brick, or coke would have prevented fire and explosion.

Still, the Lunge powder is the most economical of the purifiers, but it leaves a strong chlorine odor, which has to be removed by washing with lime water. If the gas contains ammonia, the use of the Lunge powder may be dangerous.

As hydrogen phosphide is the most harmful of the gases, it is important to recognize its presence in acetylene. In most cases, it is revealed by the odor, or by the color of the flame. But the smallest quantity can be detected by the reagents—either cupric sulphate or a mixture of chlorhydric acid and mercuric chloride.

The properties of acetylene gas are now fairly well established; 1 liter of pure acetylene of 0 degree weighs 1.161 grammes. Pure acetylene does not attack copper. Impure, and especially with ammonia, it does attack copper, which affords another process of quantitative analysis.

The employment of acetylene depends oftenest on the price of the carbide. In many cases, it is costly for lighting purposes. If we take the price at New York, the ratio between the cost of the ordinary lighting gas and that of acetylene, with light of equal intensity, is as 0.5 to 1—that is, double.

But there are localities where the ratio is inverted, where acetylene is the least costly of the two. In these localities petroleum is the only competitor, and if acetylene cannot be lowered to the price of petroleum it still will be superior, if considerations of convenience and health are taken into account.

At present in Scotland, Ireland, and England, numerous houses and shops are lighted with acetylene. At Scarborough, the city and suburbs are lighted with diluted acetylene. The ordinary gas pipes serve for its distribution. It is asserted that this gas costs only one-third as much as ordinary gas, and possesses a lighting power ten times greater than coal gas.

The Omnibus Company, as known, lights the vehicles of the Louvre-St. Cloud line with acetylene.

In Germany, the Berlin post office and numerous railway stations are thus lighted.

In France, there are more than 200,000 acetylene burners in use.

In countries where coal is dear or electricity little employed, acetylene is in frequent use—such as Greece and Western Hungary.

The mixtures of acetylene with other gases are the object of frequent experiments, mixtures either with air, with oil, or with ordinary lighting gas. A mixture of 25 per cent of acetylene and 75 per cent of coal doubles the lighting power of the latter. The intensity of light increases with the proportion of acetylene, and reaches its maximum when the two gases are in equal quantity.

If the price of acetylene is set at Paris at 0.47 franc, that of coal gas at 0.15 franc, the mixture with 25 per cent would come to 23.21 centimes; of 40 per cent to 27.98, and of 50 per cent to 31.15 centimes.

The possible danger in the use of acetylene must be considered. In 1899, explosions are recorded, by which two persons were killed and three others injured. Of 49 accidents occurring since 1897, half were occasioned by an overproduction of the gas in apparatus called automatic. As soon as the charge of carbide exceeds 2,600 kilometers, it is indispensable to stop the automatic apparatus.

Under normal pressure and temperature, acetylene gas is not more dangerous than other lighting gas. With a little scientific knowledge on the part of engineers and manufacturers, and a little prudence and good sense in the management, the proportion of accidents ought not to exceed that occurring in gas manufacture.

THE MAHL AND DE NITTIS OLEOTHERMIC BOILER.

THE very interesting problem of the production of steam at a high tension has recently been solved by Messrs. Mähl and De Nittis in an elegant and original manner. Up to the present the tentatives made in this direction have not given very favorable results, and the necessity of using metal of considerable thickness for the boiler-tubes involved the construction of apparatus of impracticable dimensions. Despite such excessive thickness, the state of solidity of the tubes yielded in a comparatively short time to the action of the fire. Nevertheless, it is of great importance to obtain steam at a very high pressure under conditions of perfect safety, since the rendering in work of the mechanical power of the heat obtained effects a very considerable saving.

The oleothermic generator which the inventors above mentioned exhibited to the International Congress of Applied Mechanics at the session of July 20, appears to combine all the conditions desired; that is to say, it offers every guarantee of safety and convenience that we have a right to require of a generator of steam. The failures that have followed the attempts to produce steam at a very high tension by employing water exclusively led Messrs. Mähl and De Nittis to make a trial of a liquid capable of becoming hot without entering into ebullition until it has reached a very high temperature. Such is the case with mineral oil, which is the liquid employed. Owing to a light and invariable tension of steam established upon the surface of this, it is possible to exceed a temperature of 300 deg. C. without the production of any vapor of oil.

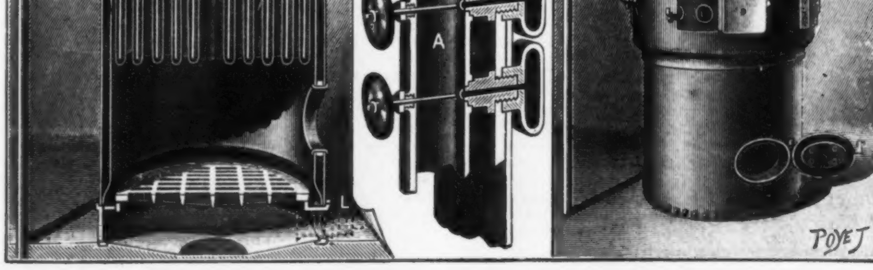
In November, 1898, M. Lockroy, Minister of the Marine, appointed a technical commission, with M. Guyot as reporter, to take account of the experiments that were then in progress. Such experiments showed the following facts: First, that the apparatus, when exposed to the most intense fire that could be produced, operated perfectly; second, that there was a very regular production of absolutely anhydrous steam; third, that there was a maximum of heat integrated in such steam owing to the very feeble temperature of the gases at the chimney; fourth, that the temperature of the bath of oil was invariably 100 degrees higher than that of the steam formed, whatever was the activity of the fire; fifth, that it was possible to obtain the high pressures of from 100 to 200 kilogrammes per square centimeter by retarding the boiling point of the oil through a slight tension of steam upon its surface; and sixth, that it was possible to raise the oil to a temperature bordering upon 500 degrees without any fear as to the effect of the heat upon the metal containing the liquid under pressure, which could thus, through calorific action, produce steam at a temperature bordering upon 400 degrees, giving a pressure of 200 kilogrammes per square centimeter. Such are the principal points that were brought out at the inquiry instituted by order of the Minister of the Marine.

The practical generator has since been perfected, and the remarkable results mentioned above have been definitely affirmed.

A glance at the accompanying figure, which represents the apparatus in sectional elevation and perspective, will allow its operation to be easily understood. The oil, which is heated in the vicinity of the furnace, in Field tubes, rises and becomes cooled in contact with the tubes existing in the upper expansion reservoir. These tubes are traversed by water from the generator reservoir. Then the oil descends to become heated anew, thus always making the same cycle in order to convey the heat. The steam formed in contact with the bath of oil, in flowing as far as to the collector, becomes sufficiently superheated to render it anhydrous.

The water tubes are flat and sinuous, and, since there is no external agent to alter the metal of which they are formed, they may have only the thickness necessary to make them resistant. As for the oil tubes they are as thin as it is possible to make them. The vaporizing tube is doubly wound. One of the extremities gives access to the water injector and the other allows of a disengagement of the steam into a collector. The solution of the problem of very high pressures thus obtained has evidently a wide future before it. The transformation of the present systems of steam motors for the utilization of powerful forces under a feeble volume, rendered possible by Messrs. Mähl and De Nittis's invention, will doubtless soon follow.

It is already permissible to look for a solution of the as yet obscure problem of flying, to mention but one of the most remarkable of the scientific researches facilitated by Messrs. Mähl and De Nittis's researches. The transformation of the steam motor, increased in power and reduced in weight and dimensions, will be followed by us with interest; and it is unnecessary to say that we shall be the first to make known the new industrial purposes for which the oleothermic boiler is used.—La Nature.

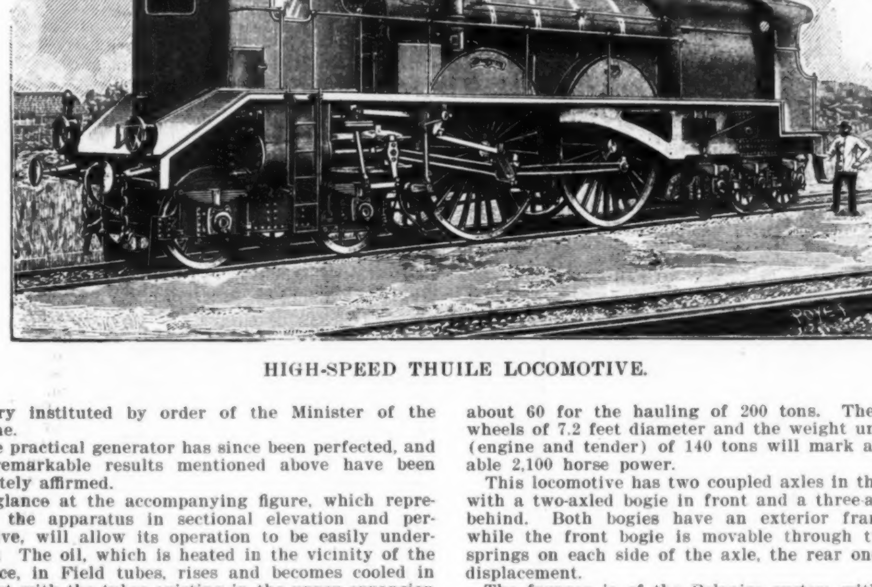


THE MAHL AND DE NITTIS OLEOTHERMIC GENERATOR.

1. Elevational Section—*A*, water injector; *B*, steam outlet; *C*, vaporizing worms; *D*, field tubes; *E*, valve of the oil chamber; *F*, valve of the steam chamber; *G*, cock for tension of steam; *H*, thermometer; *I*, pressure gage; *K*, smoke vent; *L*, petroleum burner. In the upper cartouche—Vertical section of the vaporizing worm. In the lower cartouche—Section of the injector. 2. General View of the Generator.

A CREUSOT HIGH-SPEED LOCOMOTIVE.

THE exhibit of Creusot at the exposition offered, among other first-class objects of its manufacture, a locomotive constructed after the plans of M. Henri Thuile, chief engineer of the port of Alexandria and president of the Société des Trains Internationaux. This locomotive was built with the object in view of attaining speeds of 72 miles and commercial speeds of about 60 for the hauling of 200 tons. The driving wheels of 7.2 feet diameter and the weight under load (engine and tender) of 140 tons will mark an attainable 2,100 horse power.



HIGH-SPEED THUILE LOCOMOTIVE.

This locomotive has two coupled axles in the center, with a two-axled bogie in front and a three-axled one behind. Both bogies have an exterior frame; but, while the front bogie is movable through two plate springs on each side of the axle, the rear one has no displacement.

The furnace is of the Belpaire system with a Ten-Brinck boiler. The tubes, which are of the Serve type, are 183 in number and have an external diameter of 0.28 of an inch.

The grate surface is 50.3 square feet, and the total heating surface 320 square feet. The effective pressure in the boiler is 215 pounds to the square inch.

The cylinders, which are 20 inches in diameter, with a piston stroke of 28 inches, have cylindrical slide valves with a double orifice of admission. These valves are balanced through a communication of the interior of the segment with the cylinder. The distribution is of the Walschaert type. The brake, which is of the Westinghouse system, acts upon the four driving and coupled wheels.

The engine has a cab in front for the engineer and one in the rear for the fireman. The fireman watches the feed, the water level and the blower, and the engineer attends to the Gresham sandbox, and the Laval dynamo turbine for lighting. The two platforms are connected by a speaking tube and an alarm gong, and, in case of accident to the engineer, a cock of the brake may be maneuvered by the fireman.

The tender has a capacity for 7,000 gallons of water and 7 tons of fuel. The ten wheels are, as before stated, acted upon by the Westinghouse brake, and there is also a brake actuated by hand. The diameter of the wheels is 3.28 feet. Almost all the parts of the engine are of steel. The driving wheels as well as the cross-stays of the frame are of cast steel. The connecting rods, cranks, piston rods, boiler plates and rivets are of nickel steel.

Upon looking at this powerful engine we are reminded of the terrible accident of which the engineer who combined all the parts of it and superintended its construction was the victim. In June, 1900, M. Thuile got aboard of his locomotive upon the State line. Upon the crossing of a bridge the unfortunate engineer leaned forward from the platform beyond the line of the track so that his head came into contact with the masonry of the bridge and was crushed.

This improved locomotive, through the progress made in its construction, permits us to foresee a remarkable increase in the speed of large express engines in a very near future. The experiments made by M. Worms de Romilly, Inspector General of Mines, have demonstrated the accuracy of M. Thuile's calculations and allow it to be hoped that before long the trips on the large systems of railways will be accomplished in a reduced space of time. It is but just to render homage, too, to the excellence of the work done in the Creusot establishment, which keeps in the front rank of the great manufactories of the world.

The great experience acquired, especially in the construction of locomotives, resulting from a practice dating from the origin of railways, permits this establishment to introduce into the construction of rolling stock a finish that is not always found in the large works of the kind of foreign countries.—For the above particulars and the engraving we are indebted to La Nature.

THE DISTRIBUTION OF MARINE INVERTEBRATE ANIMALS.*

THE life of the sea consists of: First, animals and plants of the shore, or littoral fauna; second, the pelagic or ocean surface fauna; third, the deep-sea fauna, below the limit of the penetration of sunlight. Shore fishes very rarely venture out of the shore zone into the open sea, or into the depths; nor do ocean fishes nor whales venture into the shore fauna, except by accident.

The short, or littoral, fauna is the only one accessible to ordinary observation. Experiments made in certain Swiss lakes showed that very sensitive photographic plates responded to light down to about 250 meters (that is, something less than 150 fathoms); but below that no plate could be gotten delicate enough to show the presence of light; and as these Swiss lakes are bodies of very clear water, it is likely that light sufficient to really affect animal or vegetable life does not penetrate much, if any, beyond 150 fathoms in the sea. For practical purposes the 100-fathom line is generally taken to mark the limit of the shore, or littoral, fauna. Everything below that belongs to the deep-sea fauna. The presence of light makes it possible in the shore fauna for plants to grow, thus affording a supply of food for herbivorous shore animals.

Then again, another feature of the environment is the solid bottom which the animals have to rest upon, live upon, or hide in; and this enables shore animals to build up heavier skeletons, either for support or protection, than pelagic animals. This weight is of great advantage, to begin with. Most shore mollusks are provided with strong, heavy shells, except burrowing kinds, which are protected in their burrows from the dash of the waves. The crustaceans and echinoderms of the littoral fauna are protected by well-developed skeletons; corals also have strong, calcareous structures. In the littoral zone, crabs, echinoderms, and mollusks crawl along the bottom; while corals, actinians, barnacles, etc., are fixed, or sessile.

If the shore fauna produced young which settled down to live in the same place as their parents did, there would be a certainty of overcrowding, and the large majority of shore animals—whether mollusca, echinoderms, or fishes—being carnivorous, the young would stand every chance of being eaten up. So almost every one of the shore fauna produces young that float freely about in the water when hatched from the egg, being carried by the current from the thousands of hungry mouths waiting to devour them. These embryos subsist upon the innumerable microscopic life of the sea, and lead what is practically a pelagic life for a certain period of time until they have become large and strong enough to settle down upon the bottom and compete with the fauna of the shores.

A certain proportion of the swimming embryos of the shore mollusks, etc., get carried out to sea and are lost, or eaten by pelagic animals; but some thus carried out make other shores, and spread the faunas further. The whole of the marine fauna of the Bermuda Islands is a tropical West Indian fauna, and has doubtless been derived from these floating and swimming embryos which have been swept there by the Gulf Stream and have gone ashore on the Bermudas. Doubtless millions of embryos are swept past there every year into the North Atlantic, and a good many of these might land finally on the coast of Iceland and set up a West Indian colony there, were it not for the barrier of low temperature.

The land faunas of North America are limited in their northward range by certain temperature lines, beyond which they either cannot live or reproduce. Most marine animals likewise have a northern temperature limit of distribution. As on land some animals pass these limits, in the sea a few do. For the great mass of marine life it is as impossible for them to live out of their zone of temperature as it is for an alligator or an orange-tree to live in the Northern States; but the free-swimming or floating embryo gives most marine and invertebrate animals an opportunity for wide distribution such as very few land animals possess.

The Isthmus of Suez, only 72 miles wide, parting the Mediterranean from the Red Sea, separates very widely diverse faunas. The Red Sea has an Indian Ocean fauna, and the Mediterranean a modified Atlantic Ocean fauna. Only a very few species are common to the seas on both sides of the isthmus. There is a greater resemblance between the faunas of the Mediterranean and the Gulf of Mexico, several thousand miles apart, than there is between the Mediterranean and the Red Seas. A number of Red Sea sharks have, however, made their appearance in the Mediterranean—much to the detriment of the fisheries there; and some echinoderms and a few mollusks have also found their way into the Mediterranean. No Mediterranean forms have yet been reported from the Red Sea, I believe. Similarly, the Isthmus of Panama separates very widely diverse faunas; but in this case our proposed Panama Canal will not result in any mixture of the faunas, for the reason that it is to be a fresh-water canal, and therefore no marine animals can pass through it.

Shore faunas, therefore, are limited in an east and west direction by the continental masses, and in a north and south direction by temperature lines. These limitations cut up the faunas of the world into more or less definite assemblages of species, each one with its own peculiarities; so that an expert can generally tell on sight from what part of the world a particular marine animal comes by its general appearance, even, in many cases, when he does not know the particular species he sees; there is often much in the *facies* or appearance of an animal which connects it with a certain fauna.

The greatest of all the faunal regions for shore animals is the Indo-Pacific region, including the Indian Ocean and the whole of the mid-Pacific or Polynesia, but not the West American tropical coast which forms the Panamaic region. This Panamaic region, by the way, is very distinct from the Indo-Pacific, and in its animals is more related to the fauna of the Gulf of Mexico. This is to be expected, because up to about the Middle Tertiary, perhaps, the Isthmus of Panama was submerged, and the Panamaic region and the Gulf of Mexico formed one marine region together at that time. This mixture of Gulf and Panamaic forms is very well seen in the fossils of the Oligocene beds of the island of Santo Domingo and of Jamaica.

The absence of a solid substratum or bottom for the animals to rest upon renders the life of the pelagic region exceedingly different from the shore fauna, precluding the development of heavy protective structures—such as the hard, strong shells of crustaceans, echinoderms and mollusks. The shells in the pelagic fauna are reduced often to the thinness of paper, or lost, as in many naked marine mollusks which are free-swimming. The peculiarity of the pelagic fauna, however, is the enormous number of individuals. Prof. W. K. Brooks relates that on a cruise of two weeks from Cape Hatteras to the Bahama Islands he was surrounded night and day by a vast army of dark-brown jelly-fishes, every bucket of water lifted up containing some of them. The cruise extended over 500 miles, tacking east and west over a space of perhaps fifty miles; and everywhere these jelly fishes were in abundance. The naturalists of the "Challenger" found the waters of the Pacific swarming with life. The ship often sailed through great banks of pelagic animals. In the Indian Ocean, Ernst Haeckel, in that wonderful book, "India and Ceylon," says that "the Indian Ocean at night was an unbroken sheet of sparkling light. Water dipped up contained such a thick swarm of luminous animals, minute crustacea, jelly-fishes, etc., that a printed book might be read by its light."

From this it will be seen that pelagic life is incredibly abundant—vastly more so than life on the land or on the shores. All these animals, from whales down to minute crustacea of which a thousand could find room in a pint of water, are engaged in devouring one another. They are all carnivorous. As Prof. Brooks says: "Insatiable rapacity must end in extermination, unless there is some unfailing supply. This supply we find in the microscopic life of the ocean water. The total number of larger organisms in the sea is inconsiderable compared with the infinite number of minute, simple, low forms of life, chiefly protozoa and unicellular plants."

The uniformity of distribution throughout the sea water of the mineral matters upon which plant life feeds obviates overcrowding, and is generally favorable to the multiplication of plants; each individual is bathed on all sides by nutritious food, and for this reason there is no tendency for the plants to build up large colonies of cells—that is, large plants. The tendency is entirely to keep the number of cells down. As soon as a cell reproduces, its offspring is separated off from the mother-cell in order to give each cell the greatest possible amount of surface in contact with the water from which it derives its nutriment; so that in this way there has been in the sea a survival of these minute, unicellular plants, which are multiplied to such degree there that, as I have said, they supply the food for all the animal life of the oceans.

In this connection it might be well to mention Prof. W. K. Brooks' theory of the origin of the higher or multicellular animals. The oldest fauna of which we have any distinct geological record is in the Lower Cambrian. In rocks of this age, as Walcott has shown, we have representatives of all the great animal groups we know to-day, except the vertebrate animals. There were sponges, echinoderms, brachiopods, mollusks, gasteropods or snails, bivalves, and in fact all the groups with the exception of the backboned animals. Now, it is remarkable that at this early time—this very dawn of life, as we might think—we should find so many entirely diverse animals; in fact, Brooks, in discussing the matter, uses as an illustration the fact that if a modern zoologist were to have been put down on the shore of that ancient Lower Cambrian Sea he would find animals (with the exception of the vertebrates) for all the branches of investigation that the zoologist has now at a seaside laboratory. He could take up the mollusca or annelids, sponges or echinoderms—any of the main forms of life—and find apparently typical material, as far as we can judge from the fossils; and the general problems of the biologist, whether of embryology, cell-structure, or the relationships of the great groups of animals, were just the same then as they are now. Prof. Brooks believes that when animals once settled on the bottom the advantages were so very apparent that very rapidly the main animal types were developed, and while they had already existing imperfect forms in the pelagic fauna, the types of structure were stereotyped, so to speak, by the development of hard parts when they settled down upon the bottom. The Lower Cambrian fauna, then, is one of these early colonies; and the reason we have not fossil remains of the really primitive animals, which would be connecting links between the echinoderms, mollusks, and worms, etc., is because they were all soft, ocean-surface animals, without hard skeletons. This theory is popularly known as the theory of the discovery of the sea-bottom; and it seems to me a very probable one.

In the modern pelagic fauna, then, the unicellular plants and the protozoa are to be regarded probably as direct descendants from the earliest fauna of the sea; whereas the higher oceanic animals, such as the fishes and the squids, and the swimming tunicates, such as Salpa, etc., are derivatives from the shore fauna; they are animals which were developed on the shore and took anew to pelagic life, becoming adapted to oceanic conditions secondarily.

Now, in the deep-sea or abyssal region we find that both the conditions and the limitations of living beings are profoundly different from those of either the pelagic or shore faunas. The principal factors in the surroundings of animal life in this region are: The *absence of light*, the upper limit of the abyssal region being located in practice at about a hundred fathoms' depth, but in theory at the limit of penetration of sunlight; secondly, the *low temperature*, the warm water of the sea being confined really to a layer only along the top, the deeper water being cold. Another factor is that the water is still; there is none of the play of waves which has been so important a factor in developing hard parts in shore animals. The only movement, probably, is the soft gliding of ocean currents, and these very rarely extend to great depths. Still another factor is that animals live under a tremendous pressure from the weight of the water. Now, the absence of sunlight in the deeps results, of course, in an entire absence of plant life. The nutritive processes of plants go on only by the aid of sunlight, as is well known. All deep-sea animals are therefore carnivorous. Again, in the absence of light, bright colors would be of very little use to the animals, and we find, as a matter of fact, that all deep-sea fishes and most deep-sea mollusks are either dull or pale-colored. There is none of the brilliant variegation of shore shells or of shallow-water fishes. However, there is an exception to this color rule in the star-fishes and the crustacea, which are very frequently colored more or less brilliantly; but in these cases the color is nearly always red, or some of the tints around the red part of the spectrum.

In the absence of plant life all deep-sea animals are carnivorous. It is obvious, however, that, however numerous they may be, they would finally eat each other up, were there no other source of food. From the stratum of surface animals there must be constantly sinking millions of individuals which have either died or become injured or exhausted, and which, therefore, sink slowly but constantly toward the bottom; so that on the bottom there is raining a constant supply of food from above.

In picking up the shells along any strand we will be sure to find specimens which have round holes in their shells where carnivorous mollusks have bored into them and eaten the animals; but in deep-sea mollusks this has never been observed. This is pretty good evidence that deep-sea mollusks do not feed upon one another to the extent they do at the shore; and Dall draws the conclusion that in the abyssal region the animals for the most part do not live in a perpetual state of conflict. The struggle for existence is against the physical features of the environment, and not the animals one against the other, as it is in the shore fauna.

The distribution of sea-animals is, as we have seen, limited by temperatures the same as the distribution of land animals; so that the low temperature alone would prevent any extensive incursion of shore animals into the deeps, except in the polar regions. But just as there are some species of shore animals which extend north and south over a great range of latitude, so there are a few animals which extend from quite deep water into the littoral belt, or shore zone; but these are comparatively few. Another feature of the environment in the deep-water fauna is the pressure of the water. Everyone has noticed the pressure on the body when bathing or diving even a few feet below the surface. Now, as we go down the pressure increases at the rate of about one ton to every thousand fathoms of depth; so that, while the pressure of the air column above us at sea level is 15 pounds to every square inch, the pressure at 2,000 fathoms depth would be 4,500 pounds to a square inch. It is difficult to realize this tremendous pressure. An ordinary steam-boiler, for instance, does not carry a pressure over 100 pounds to the square inch; or in a locomotive boiler it is perhaps 140 to 150 pounds; but here we have a pressure of between 4,000 and 5,000 pounds to the square inch. Rope, it is said, which has been made impervious by tarring and used for sounding in great depths, becomes reduced one-third in its dimensions after descent to a depth greater than 1,000 fathoms. Of course, any hollow object which is let down into the deep sea is immediately crushed. Alexander Agassiz, in his "Three Cruises of the Blake," relates that, following the advice of Sir John Murray, to ice wine in the "refrigerator of the deep-sea," he sent down a bottle of champagne to the depth of 2,400 fathoms. The result would be encouraging to total abstinence; for the sea-water forced in the cork, and when brought up they found an unpalatable mixture of sea-water in place of the former contents of the bottle. Of course, to withstand this tremendous pressure the deep-sea animals are thoroughly permeable to the water; so that the pressure from within is the same as without. Fishes brought up from these depths, on account of the sudden lessening of the external pressure, expand, and frequently arrive at the surface in a very disreputable condition—the scales loosened or falling off, and the air-bladder so distended that it protrudes from the mouth. Mollusca seem to stand it much better. It will readily be realized that these conditions of deep-

* Abstract of a lecture delivered at the Academy of Natural Sciences of Philadelphia, by Henry A. Pilsbry, Conservator of the Conchological Section. Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

sea life result in a very different fauna from that of the shores, or from that of the ocean surface. As a matter of fact, the fauna in 100 or 200 fathoms off the coast of New Jersey, for instance, is as different from the shore fauna of New Jersey as the fauna of Africa would be.

This deep-sea fauna, however, is only now beginning to be made known, and its investigation is attended with a good deal of difficulty. Deep-sea animals are, of course, only to be secured by the dredge or trawl, which is let down and scraped along the bottom. To illustrate this we have in the City Hall here a tower which is decidedly less than a hundred fathoms high; and it does not seem at all likely that one would get a very satisfactory sample of the insects and animals of the earth by letting down say a six-foot dredge from the height of the City Hall tower, and dragging it along over the ground at random for a short distance; but how much more preposterous does it seem when we consider a depth of say 2,000 fathoms, over two miles, a distance farther than from the Delaware to the Schuylkill River, and consider that our sample of the life of the bottom is obtained by letting down a trawl of say six feet beam, or a dredge of decidedly less width, and scraping it along a short distance on bottom which we cannot select, but have to take at random, trusting to what gets into the dredge or is caught in the trawl for our knowledge of the fauna.

In most cases where a body of salt water is cut off from the sea and fed by fresh-water, there is a total extinction of the original marine fauna, and it is replaced in due time, when the basin is converted into a fresh-water lake, by a fresh-water fauna; but in a few cases we have lakes where this process has not taken place. The fauna of Lake Tanganyika—that long, narrow, but very deep, lake in eastern equatorial Africa—has recently been studied by Mr. J. E. S. Moore, an Englishman, who finds two sets of species; one of them the normal, ordinary fresh-water species of mollusks and crustaceans, etc., which are common to Nyassa and all the African lakes; and besides these there is a set of species which belong to marine groups of animals, which have nothing to do with the ordinary fresh-water fauna. There is nothing like them found anywhere else in fresh-water lakes. This marine fauna in fresh-water Moore calls the "halolimnic," or sea-lake, fauna. It is a very interesting peculiarity that the mollusca of this fauna have relationships, not with marine mollusca of to-day, but with fossil mollusca—going to show that this lake was first separated off from the sea in the Mesozoic period, and has been separated ever since, gradually becoming fresher and fresher. In contrast with the shallows of Lake Nyassa the lakes and bays of Tanganyika swarm with crabs and prawns, and detached fragments of the deep-sea sponges are tossed by hundreds on the shores; and on the extensive rocky coasts the partially submerged stones are covered with mollusks just as the rocks swarm with periwinkles on an English beach. In putting out in the lake itself, the deep open water is filled with thousands of pelagic protozoa; and during the dry season swarms of jelly-fish are seen navigating its depths. The fauna of this lake, therefore, shows conclusively that Tanganyika is the relic of an ancient sea, which probably became freshened so gradually that its population of jelly-fishes, crabs, and mollusks were able to adapt themselves to the changing conditions, and therefore did not become extinct.

One other lake seems to have a similar history, and only one other, so far as we now know—that is, Lake Baikal in Siberia. It has been known for some time that sponges of marine types were found in Lake Baikal, but it is only recently, during the present year, that the discovery of nudibranch mollusks, announced by Dr. Dybowski, confirms the idea that Baikal is one of these relic lakes, or "relictenseen," as the Germans call them. Nudibranches are, of course, an exclusively marine group of mollusks. The probabilities are that Lake Baikal is, like Tanganyika, an ancient arm of the sea, which has been cut off and gradually freshened.

In concluding, if we compare marine and land faunas we find, as a general rule, very much less localization of species in the marine, than in the land, fauna. Species have a much wider distribution. This is owing, not only to the fact that there are fewer barriers in the sea than on land, but to the very wide spread of marine animals by their floating embryos. In the pelagic and deep-sea faunas we have conditions analogous to nothing in the land faunas, and, as we have seen, there is reason to believe that the pelagic fauna—the floating animals of the open sea—gave rise to all the living things of the earth.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Market for American Lumber in France.—Under date of February 27, 1901, Consul Skinner reports as follows upon the demand for walnut logs in France:

A scarcity of walnut logs for the manufacture of furniture is reported to me by dealers in this city, who express a wish to get in touch with American firms able to supply both light and dark colored walnut. All kinds of exotic woods in logs are admitted free of duty; squared lumber is dutiable at the rate of 24 cents per 220 pounds. While walnut is the timber most in demand and the most difficult to obtain, there is also an opportunity to dispose of ebony and mahogany, if American firms are at present prepared to export these woods from our colonial possessions.

The walnut logs should not be less than 14 inches in diameter, nor less than 9 feet in length. Sawed lumber should be at least 1 inch thick and preferably thicker. The buyers desire a timber that is handsomely veined and free from blemishes. Present prices are about $19.30 per 1.308 cubic yards for logs and $24.12 per 1.308 cubic yards for sawed lumber. While it is desirable that American firms quote c. i. f. prices, this is not imperative if f. o. b. prices at Baltimore, New York, or New Orleans are named. There is frequent direct steamship communication between the three ports named and Marseilles, and there is also a line of Italian sailing ships from Pensacola. The most frequent sailings from New York to Marseilles are those of the Cyprien Fabre Company and of the Anchor Line.

The Lapalud Company, 183 rue Ferrari, manufacturers of furniture, claim to be able to absorb over 2,000 cubic meters themselves, and believe that there is an opening for an extensive business with other local firms and cities in the interior. In addition to the firm named, the other resident buyers who might be interested in receiving quotations are:

Alexander Facio, 2 Place du 4 Septembre.
Bonifay & Galibert, 118 Boulevard National.
Reg Miallon, 81 rue Chauteau Payan.

The above make a specialty of exotic woods.

C. G. Bergman, 53 rue Grignan, and A. Sylvander, 15 Cours du Chapitre, are extensive buyers of American pitch pine and might perhaps do something in walnut if advantageous propositions were made to them.

I would suggest that American exporters place themselves in direct communication with one or more of the foregoing firms, and I shall be happy to facilitate the opening of business relations in any way within my power.

The following are extracts from a letter from Consul Skinner, of Marseilles, dated February 27, 1901, in answer to the inquiry of a New York firm relative to the pitch pine trade of that city:

All of the American pine imported at Marseilles is purchased from London middlemen. I have had occasion to investigate this matter, and discover that the occasional efforts made in this city to buy direct have been extremely unsatisfactory. Justly or unjustly, the local buyers attribute to the actual exporters in the United States an unwillingness to conform strictly to contract specifications, both as respects quality of wood and agreement as to terms. It is pretended that the American firms, as a rule, have very limited capital, and, as the average cargoes received in Marseilles are worth about $20,000, the resident buyers prefer to take no risks and to lose something like 3 per cent, which is absorbed by British middlemen; hence all business is done by that indirect method.

The firms of Price & Pierce, 27 Clement's Lane, London, and Tajart, Beaton & Company, 2 Great Winchester Street, London, are reported to me to be the actual importers of fully 80 per cent of all the American lumber shipped to England and the Continent. These two houses send their representatives into the Florida and other pine regions, who supervise every detail preceding the actual departure of the lumber for its final destination. Having practically unlimited capital, they advance money on as much as a year or even two years' time to the American millers, and assume responsibility for satisfactory delivery to the Marseilles buyer. The American exporters send their representatives to Europe annually, but they visit the trade with the agents of the two British firms. The operation as I have described it has been conducted for so long a time and with results so satisfactory to the European buyers that in Marseilles, at least, propositions for direct sales are very skeptically received, in spite of the obvious advantages of such a method. The local firms with which the Marseilles brokers do business would prefer to be freed from the present obligation of dealing with the London concerns, but the brokers insist that they can afford to take no chances.

I am free to say that the system as it exists is irrational, but it will require persistent and well-directed effort on the part of our exporters to divert from London to the United States a business which has been built up with great pains and rests upon a broad foundation of mutual confidence and esteem.

What is true of the lumber trade is also more or less true of many other commercial lines, and I think it would surprise a great many American business men if they could realize the extent to which they are dependent upon British middlemen for their foreign trade. Exports are made direct to buyers from many American ports, and casual inspection of shipping manifests would indicate that this business is controlled in all its details by the American seller; but when the facts are investigated, it more frequently than not is shown that the actual negotiation is intrusted to important British or continental firms, which are thus in a position to swing the trade from the United States to any other exporting country the moment conditions seem favorable for such a diversion.

The growing tendency of our people to establish themselves abroad and cut off commissions and to operate directly is one that cannot be too strongly encouraged, and I know of no branch of our business in which efforts along these lines would be more appropriate than in our lumber trade.

New Railroads in the Ural.—Under date of February 21, 1901, Consul Hughes, of Coburg, reports as follows:

Compared with the extensive mining operations in the Ural, the transport accommodations have been very inadequate. The railroads in the mining district have a total length of only 312 versts (207 miles), viz., 150 versts (93 miles) belonging to the Demidof factories, 100 versts (66.3 miles) in the Bogolowski district, 40 versts (26.5 miles) belong to Alapajewsk, and 22 versts (14.6 miles) to Lyowa. Preliminary surveys are being made for the purpose of constructing new railroads which will bring the total length of track up to 1,792 versts (1,188 miles). One line will connect the Lywenski works with the existing Samara-Slatouet line, and will be 720 versts (477 miles) long; while a second line, 760 versts (504 miles), will run in the direction of Newjansk-Irbit-Tabarinokoje. These lines, it need scarcely be mentioned, will be a great help to the mining and reduction furnace work in the Ural.

Berlin-Hamburg Rapid Transit.—Experiments are now being made by the firm of Siemens & Halske, of Berlin, with electric trains having a speed of 125 miles an hour. The main objects of these experiments is to complete the technical improvements for the wheels, necessary on account of the greatly increasing rotation.

These experiments, it is now stated, have demonstrated that a speed of at least 125 miles per hour can be attained without difficulty. In using electric motive power, a transformation of the horizontal motion of the piston into one of rotation of the wheels is not necessary; the rotary motion of the motor can at once be transmitted to the axle of the coach or the motor axle can serve at the same time as the coach axle.

A pamphlet issued by the privy councilors of engineering—Messrs. Philippi and Griebel—states that with such electric roads of great speed, surface crossing is out of the question; railroads, streets, passages, and canals must be crossed either by bridges or tunnels. The quick succession of trains (intervals of six minutes) makes it imperative that the tracks must be kept clear at all times while being operated. Neither the public nor employes can be permitted to enter upon them. For this reason, the three-track system must be adopted and switches are to be avoided.

The plan for this rapid electric road between Berlin and Hamburg is as follows: The road will run between a point immediately adjoining the city of Berlin and one adjoining the city of Hamburg. The total length of the line will be about 156 miles. The subways and elevated tracks are already projected for the whole line. The estimated cost, according to Messrs. Philippi and Griebel, is $33,000,000, among which are $4,400,000 for the right of way, $7,200,000 for grading, $10,000,000 for construction, and $5,000,000 for electric power stations, passenger depots, and workshops.—Richard Guenther, Consul-General at Frankfort.

Liquid Air and Low-Grade Fuels.—The following, dated February 23, 1901, has been received from Consul-General Guenther, of Frankfort:

The London Engineer speaks of a remarkable use of liquid air through the invention of a German engineer, Mr. Hempel.

He utilized the fact that in the evaporation of liquid air, nitrogen evaporates more rapidly than oxygen, so that finally a gas remains containing a high percentage of the latter element. Mr. Hempel tried to make use of this in firing with low-grade fuel, like brown coal and peat, and for that purpose constructed a peculiar furnace.

At some distance from the firing room a vessel containing liquid air is placed, the contents of which naturally evaporate gradually. The first gases, rich in nitrogen and thereby impeding the process of the burning of the fuel, are allowed to escape; the later gases, however, consisting of 50 per cent of oxygen, are led under the grate and cause a lively fire.

The practical employment of this ingenious process depends upon the local price of liquid air.

American Goods in the World's Markets.—The following, dated February 1, 1901, has been received from Consul-General Guenther, of Frankfort:

In a recent publication, the Frankfort Chamber of Commerce calls attention to the growing American competition in the markets of the world. It says:

The harbor authorities of Calcutta advertised for bids on locomotives. The lowest English bid was 30,880 marks ($7,349) for each locomotive, to be delivered within nine months; the lowest American bid was 25,200 marks ($5,998), delivery within six months. The American firm received the contract. The contract for furnishing a large quantity of cast iron pipes for the Dutch colonies was some time ago awarded to an American firm, which underbid German competitors nearly 25 per cent. Lately, large orders for rails were placed in America from Holland. Even the English government is obliged to give Americans the preference over their own works on account of lower prices and quicker delivery, as in the construction of the Uganda bridges. American competition will be felt, especially in the Chinese market, after the cessation of hostilities. A number of new steamers are already being built for the trade between San Francisco and Japan and China.

A movement is on foot to establish a commercial museum at San Francisco after the pattern of that of Philadelphia. This will be of great service to American commerce with East Asia.

Dried Apricots in Germany. — Consul-General Guenther, of Frankfort, under date of February 13, 1901, calls attention to the fact that under the German law dried fruits which have been treated with sulphur are considered injurious to health and are liable to be confiscated, confiscation having actually taken place in several cities.

The consul-general further states that he has been shown two reports by the Chemical-Technical and Hygienic Institute, of Frankfort, relative to samples of dried California apricots, one of which samples showed the presence of 0.03376 per cent of sulphurous acid and the other 0.182 per cent.

If the authorities become cognizant of this fact, continues Mr. Guenther, not only will this fruit be confiscated, but the German dealers, rather than get into difficulties with the authorities, will discontinue the trade.

The consul-general adds that Germany's importation of California dried fruits is increasing, and advises United States exporters to be careful to observe the German laws and not subject their shipments to confiscation. The two consignments of apricots of which samples were analyzed were not shipped directly from California to Frankfort, but were procured from middlemen.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Protecting Stuffed Furniture from Moths.—The stuffing, no matter whether consisting of tow, hair, or fiber, as well as the covering, are coated with a 10 per cent solution of sulphur in carbon sulphide. The carbon sulphide dissolves the sulphur so as to cause a very fine division and to penetrate the fibers completely.—Lack- und Farben-Zeitung.

Protection for Safes.—The most effective electric protection for safes consists in covering the safes, inside and outside, with a fabric into which conducting metallic threads are woven in sufficient closeness. Not even the smallest hole can be made into the safe without cutting one of the threads whereby the current is interrupted and the alarm-bell sounded.—Technische Berichte.

Substitute for Ebonite and Wood.—Acetic paraldehyde or acetic aldehyde, respectively, or polymerized formaldehyde is mixed according to Arthur Schmidt with methylic alcohol and carbolic acid, as well as fusel oil saturated with hydrochloric acid gas or sulphuric acid gas or methylic alcohol, respectively, are added to the mixture. The mass thus obtained is treated with paraffine. The final product is said to be useful as a substitute for ebonite and wood as well as for insulating purposes.—Pharmaceutische Zeitung.

Mending Celluloid.—Celluloid dishes which show cracks are easily repaired by brushing the surface repeatedly with alcohol 3 parts and ether 4 parts until the mass turns soft and can be readily squeezed together. The pressure must be maintained for about one day. By putting only 1 part of ether in 3 parts of alcohol and adding a little shellac, a cement for celluloid is obtained, which, applied warm, produces quicker results. Another very useful gluing agent for celluloid receptacles is concentrated acetic acid. The celluloid fragments dabbed with it stick together almost instantaneously.—Deutsche Uhrmacher Zeitung.

Viscin.—As an adhesive agent for medicinal purposes Prof. Reihl, of Leipsic, recommends the viscous substance contained in the white mistletoe and consisting of several little-known substances. It is largely present in the berries and the bark of the said parasitic plant; it is called viscin, and can be produced at 1-10 the price of caoutchouc. Solutions in benzine may be used like those of caoutchouc without causing any irritation if applied mixed with medicinal remedies to the skin. Perhaps there are other uses to be gotten from this plant, whose only value so far consisted in the production of bird lime now prohibited in Germany.—Neueste Erfindungen und Erfahrungen.

Preservation of Shoe Soles.—A. Conrady recommends solid petroleum as an excellent sole protector. He describes the production of this substance as follows:

Dissolve ordinary household soap in water; on the other hand, dissolve an aluminum salt—the cheapest is the commercial aluminum sulphate—in water and allow both solutions to cool. Now pour the aluminum salt solution, with constant stirring, into the soap solution, thereby obtaining a very fine precipitate of aluminum oleate. The washed-out residue is dried with moderate heat. By adding 10 to 30 per cent to petroleum with slight heating, a solid petroleum of vaseline-like consistency is received, which may be still further solidified by additional admixture. A 10 per cent solution of aluminum oleate in petroleum is a very excellent agent for preserving the soles, a single saturation of the soles sufficing forever. The sole will last about one year.—Neueste Erfindungen und Erfahrungen.

Effect of Oil-Cake Feeding on the Butter.—Rape-seed cake does not exercise a favorable effect upon the quality of the butter, says the Wiener Landwirthschaftliche Zeitung. This is especially the case if the quantity given exceeds 1 kilo per head and day. Owing to the mustard oil contained in the rape-cake, the butter is very liable to turn sharp, oily like train-oil, and soft. Small rations are advantageous at times, especially in feeding beet leaves and oat-straw, which render the butter hard. Rape-cake has an unfavorable action upon cows with calves, or pregnant ones. In many sections, as, for instance, England, the use of rape-seed cake has been entirely abandoned, and in many German dairies the furnishers of milk are expressly forbidden from feeding them to their cows. Sunflower cakes, mostly coming from Russia, are a very pleasant feed for cattle, but are more suitable for fattened cattle and draught cattle than for milch-cows. Linseed-oil cakes, however, are one of the most palatable, nutritive, and digestible feeds for strength, and also have a dietary effect. The butter obtained by feeding linseed cakes possesses good qualities, but is very liable to become too hard if large rations are given. It is always advisable, if large portions of oil-cakes are fed, to mix smaller quantities of different varieties.

Imitation Sandarac.—Some time ago a sample of sandarac, designated "Sandaraco uso," "Sandarque en larmes lavée," was submitted to the pharmacological institute of the Vienna University. As regards the origin of this exceptionally handsome and uniform merchandise, which was regarded as suspicious by the firm submitting the sample, all that could be ascertained was that it was supposed to come from Spain. The sample consisted of rather uniform, pale lemon-colored, transparent pieces, which were brittly conchoidal in fracture, but mostly pulverulent at the fracture-walls; in chewing, they were in the beginning reduced to powder, like genuine sandarac, but later on stuck to the teeth. In the water bath, the pieces became soft, and finally ran together into a tough mass. The specific gravity was determined to be 1.067, the melting point about 100 deg. C., the ash percentage was 0.02 per cent; the acid number 169. In spirit of wine, hot linseed oil, turpentine oil, chloroform, and glacial acetic acid, the sandarac was perfectly soluble; partly so in petroleum-ether, carbon-sulphide, chloral-hydrate, and dimly soluble in ether. The alcoholic solution remains clear upon admixture of alcoholic potash lye. The article is a clumsy sophistication, the would-be sandarac consisting principally of colophony.—Lack- und Farben- Industrie.

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